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Editorial

Nutrient Delivery Systems: The Future Strategy for Chronic Diseases

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Editorial

Chronic diseases, including heart disease, cancer, diabetes and inflammatory diseases are the leading causes of death and disability all over the world. The slowly progressing but the lethal effects of these chronic diseases are becoming a major challenge for today's pharmaceutical scientists and nutritionists. Traditional therapies have limitations in treating or preventing chronic diseases due to their complexity and inveterate nature. For instance, multiple dosages are usually needed for chronic diseases, such as cancers, in order to maintain the drug concentration in the effective window; or large dosage may be required to have the drug reach the targeted location. However, the toxicity of drugs is a major problem for long term treatment. In recent years, a paradigm shift is emerging from drugs to nutrients for the treatment of chronic diseases.

Nutrients, different from pharmaceutical agents, are the bioactive compounds derived from foods with various biological activities and little side effects. Unlike drugs which are specifically designed or synthesized for optimal efficacy to treat certain diseases, nutrients have natural origins and usually low bioavailability and poor stability. Therefore, nutrients are more delicate and labile than drugs. From a nutritionist's perspective, development of strategies to utilize nutrients as bioactive agents to treat or even prevent chronic diseases are often equally if not more challenging than drugs.

Drug delivery technologies have been receiving a great deal of attention in recent decades and are playing essential roles in treating various diseases. Recent innovations in drug delivery technologies have enabled scientists to develop novel drug carriers to deliver certain drug to specific sites *in vivo* with maximal efficacy and minimal side effects. Meanwhile, scientists are currently beginning to take advantage of drug delivery systems in the field of nutrition and food science. Being different from drug delivery systems, nutrient delivery systems are particularly fabricated for applications in foods and therefore often require extra care. First, food-derived biomaterials are required in the fabrication process to avoid potential toxicity. The desirable biomaterials include naturally-occurring polysaccharide, proteins, and lipids from food sources. Second, the fabrication process should be simple and "green", without need of specialized equipment or organic solvent to avoid metal contamination or solvent residual toxicity and thus ensure the safety of final products for human consumption. Third, the production process should be low-cost and feasible for scale-up commercialization in food industry.

Thus far, a variety of delivery systems have been investigated and successfully evaluated for nutrient delivery applications [1], including colloidal nanoparticles [2,3], nanoemulsions [4,5], nanofibers [6], hydrogels [7,8], solid lipid nanoparticles [9], etc. The type of delivery systems mainly depends upon the nutrient to be encapsulated and its delivery site in the body. Various nutrients have been studied in the development of delivery systems, including vitamins [10,11], polyphenols [12,13], essential oils [4,14], bioactive indoles [15] and peptides [16], etc. Different technologies, including spray drying, electrospinning, electrospray, freeze drying, emulsification, coacervation, ionic gelation, etc., have all been tested for their feasibility and applications in the field of food science [17].

Nevertheless, it is worth noting that most of the present research on nutrient delivery systems is primarily focused on the food processing and safety-related applications, such as prolonging shelf life, improving solubility, enhancing anti-microbial activity, food packaging, etc. Negligible literatures are currently available for their health-related applications, especially the *in vivo* biological efficacy to treat chronic diseases. While such potential applications may have been proposed or predicted through evaluation of physicochemical properties or *in vitro* models, the *in vivo* evaluations using animal studies and human clinical trials are seriously needed before any conclusions can be drawn for their effectiveness. Unfortunately, these studies are significantly lacking. How the delivery systems would affect the intestinal absorption of encapsulated nutrients and how these nutrients carried by "nano-vehicles" would alter the disease biomarkers and signaling pathways are still unknown. Although a few studies published in recent years have begun to report the biological activities of encapsulated nutrients against cancers [18] or inflammation-based [19] chronic diseases, those systems do not completely comply with food-grade production requirements, e.g. organic solvents or synthetic polymers are involved in the fabrication process.

It is a long journey to develop effective and safe strategies for prevention and treatment of chronic diseases. Nutrient delivery systems made from natural biopolymer-based vehicles represent a novel and promising approach in the future. New structural designs of nutrient delivery systems are needed to address the complexity of chronic diseases. Examples include colon-specific delivery of antioxidant for inflammatory bowel disease and ocular-specific delivery of carotenoids for eye health. The *in vivo* evaluations of biological fate of food-grade nutrient delivery systems after oral consumption and their efficacy in appropriate chronic disease animal models should be emphasized and will be one of future research directions.

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