

Exploring delivery of nutraceuticals using nanotechnology

The term “nutraceuticals” given by founder and chairman of the foundation for innovative medicine, Stephen DeFelice in the early 1980s, is made up of two terms nutrition and Pharmaceuticals.^[1,2] Nutraceuticals are defined as components/nutrients isolated or purified from foods which have health benefits besides their actual function of providing nutrition and are therefore used to prevent the occurrence of a disease or are used in its treatment. They are usually sold in medicinal forms not associated with the foods from which are derived/isolated.

The success of nutraceuticals can be attributed to their trait of imparting the desirable therapeutic benefits with a reduction in the side effects, associated with the use of pharmaceutical substances used in the prevention and treatment of various ailments.

Over the years, by doing appropriate experiments, researchers worldwide have proved beyond doubt that nutraceuticals provide protection against a number of diseases including cardiovascular diseases, cancer, diabetes, and even neurodegenerative disorders. Although the list of nutraceuticals used in the treatment of diseases is quite long, but over the past few years, phytochemicals with potential health and physiological benefits such as herbal polyphenols, to name a few curcumin, resveratrol, blueberry, rutin, and carotenoids like beta-carotene present in yellow, orange, and green vegetables and fruits have attracted researchers as well as consumers not only due to their ability to prevent and treat a number of diseases like cancers, cardiovascular disorders, and even neurodegenerative disorders like Alzheimer’s disease due to their inherent antioxidant property but also due to their beneficial effects in improving the immunity.

However, the low bioavailability associated with a majority of the phytochemicals with health benefits either due to their poor solubility in the gastrointestinal fluids thereby leading to their incomplete absorption from the gastrointestinal tract or due their first pass metabolism, resulting in their diminished or no biological activity, is a major concern of the scientists today. In

order to address this issue, principles of nanotechnology have been utilized by various researchers for the efficient delivery of these nutraceuticals with the aim to enhance their biological activity.

A number of formulation approaches like nanoemulsions, micelles, nanoparticles, nanocapsules, nanocochleats, nanocrystals, etc. have been utilized for the efficient delivery of the encapsulated nutraceutical. The developed nanoformulations provide a targeted delivery of the encapsulated phytochemical as well as its sustained release from the nanoformulation besides improving its bioavailability and hence therapeutic efficacy.

A good example to illustrate this is the tremendous improvement in the solubility and hence bioavailability of curcumin, a nutraceutical with anticancer potential which has been proved by various animal and cell culture models, by formulation of different nanoformulations like nanoparticles, micelles, and liposomes.

Although, scientists have successfully improved the bioavailability and therapeutic potential of various phytochemicals *in vitro* by formulating them as nanoformulations, extensive *in vivo* studies still need to be done to prove their efficacy. Besides this, the scientists and researchers should also ponder about the toxicity potential and safety aspects of these nanoencapsulated nutraceuticals to the human body as well as to the environment.

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