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A Review on Nanoemulsions in Food Applications

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Nanoemulsions are defined as oil droplets, with particle sizes comprised between 10 and 100 nm, dispersed in aqueous media. Nanoemulsions are thermodynamically and kinetically stable, emulsions are unstable. Various types of nanoemulsion, including single-layer, double-layers and triple-layers nanoemulsions, could be produced, depending on the polyelectrolytes, such as alginate and chitosan. The current use of nanoemulsions in food products is quite limited, but these colloidal systems hold substantial potential for purpose in several areas, generally related to the development of novel functionalities. In particular, the delivery of functional compounds, such as bioactive molecules, micronutrients, colorants, flavorings, or antimicrobial agents, into food and beverage products that naturally do not contain them is highly desired to increase product value by enhancing health benefits, nutritive profile, appearance, aroma, or shelf life. The composition and structure of these nanoemulsions can be carefully controlled to provide the required in-product protection and the desired in-body behavior. In addition, the ability of nanoemulsions to form gels can be exploited in functional food design, where nanoemulsion gels become a constitutive part of the food.
Keywords: nanoemulsions, food applications, food products.

Introduction

In the last two decades, nanotechnology has quickly emerged as one of the most promising and attractive research fields. The technology offers the potential to significantly improve the solubility and bioavailability of many functional ingredients. Nanoemulsions are defined as oil droplets, with particle sizes comprised between 10 and 100 nm, dispersed in aqueous media. The use of high pressure valve homogenizers or micro fluidizers often causes emulsions with droplet diameters of less than 100 to 500 nm (Araujo, L et al., 1999). This portion focuses on nanoemulsions and provides an overview of the production methods, materials used (solvents, emulsifiers, and functional ingredients) and of the current analytical techniques that can be used for the identification and characterization of nanoemulsions (Chaudhry, Q et al., 2008). These systems have been thought to have several advantages over conventional emulsions as colloidal delivery systems due to their smaller particle size. Nanoemulsions constitute one of the most promising systems to improve solubility, bioavailability, and functionality of hydrophobic compounds. Food industry seeks to use these systems for the incorporation of, e.g., lipophilic functional compounds in food matrices (Chau, C. F, et al., 2006).

Methods of Preparation of Nanoemulsion

Nanoemulsions have very small particle size range; they can be most effectively produced using high-pressure equipment. The most commonly used methods for producing nanoemulsions are 'High-pressure homogenization' and 'Microfluidization' used at both laboratory and industrial scale (Kim, I. et al., 2013). Other methods like 'Ultrasonification' and 'In-situ emulsification' are also suitable for preparation of nanoemulsion. Factors to be considered during preparation of nanoemulsion (Jochen, W et al., 2013).

A. Concentration of surfactant must be high enough to provide the number of surfactant molecules needed to stabilize the microdroplets to be produced by an ultra low interfacial tension (Joe, M.M et al., 2012).

B. The interface must be flexible or fluid enough to promote the formation of nanoemulsions (Kreyling, W.G et al., 2004).

C. Surfactants must be carefully chosen so that an ultra low interfacial tension (< 10-3 mN/m) can be attained at the oil / water interface which is a prime requirement to produce nanoemulsions (Kotyla, T., et al., 2008).

Application of Nanoemulsions in Food

The technological limitations of developing functional foods are the low solubility, stability, and bioavailability of the bioactive compounds (Shahidi and Zhong, 2010). Most of the bioactive food ingredients are susceptible to degradation during food

processing and oxidative deterioration during storage (Xianquan et al., 2005). Certain bioactive have low solubility but rapid metabolism which reduces its bioavailability, whereas some are volatile and sensitive to processing conditions (Jin et al., 2016). These challenges can be overcome by the use of nanoemulsions to encapsulate bioactive compounds for their use in food matrix. The encapsulation of bioactive compounds in an oil phase or emulsifier ensures it stability,
bioavailability, and controlled rate of release (McClements et al., 2007). The nanoemulsion based delivery system should have compatibility with food matrix and minimal effect on the organoleptic properties of the food such as its flavor, appearance, and texture (Pathak, 2017). The encapsulation of bioactive compound can protect it from processing conditions and prevent its degradation for long

duration from temperature, light, pH, and oxidative conditions during storage. The application of nanoemulsion based delivery system for foods requires that the technique is economically feasible for industrial scale production (Borthakur et al., 2016). The applications of nanoemulsions in food industry. Nanoemulsions have been used as a suitable form to improve the digestibility of food, bioavailability of active components, pharmacological activities of certain compounds, and solubilization of drugs.

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