Poster 46 Development of bio-based nanoemulsions to improve physical and chemical stability of omega-3 fatty acids

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Nowadays there is a high interest of food industry to develop nutritional food products. This concept promoted the development of bio-based structures to encapsulate bioactive compounds and thus enhance their physical and chemical stability during storage until the consumption. In this field nanotechnology can offers several advantages, not only improving water solubility but also in the increase of bioavailability of lipophilic bioactive compounds. Omega-3 polyunsaturated fatty acids (ω-3 fatty acids) are known for their functional properties such as: improving cardiovascular health, decrease inflammation, increase cognitive function, and influence on neurological and visual development. However, ω-3 fatty acids are highly susceptible to oxidation, have an intense odour and present low water solubility, which makes its direct application in foods extremely difficult. In order to reduce these problems, the nanoencapsulation, through the use of nanoemulsions can be used.
In this work, Lactoferrin (Lf), a protein derived from milk with a wide range of reported biological activities (e.g. antioxidant, antimicrobial and cancer prevention) was used as natural emulsifier for the development of oil-in-water nanoemulsions. Nanoemulsions were produced with a high-pressure homogenizer applied for 5 cycles at 20000 psi. Different Lf concentrations (0.2; 0.6; 1; 2; 3; 4 and 5% (w/w)) were tested. The nanoemulsions physical properties were evaluated in terms of size and ζ-potential measurements using dynamic light scattering (DLS) and by surface tension using the Ring method. The morphology of nanoemulsions were analysed by transmission electron microscopy (TEM). The physical and chemical stability of these nanoemulsions was assessed during 50 days, at storage temperatures of 4 ºC and 25 ºC, being the chemical stability of nanoemulsions was evaluated by antioxidant activity measurements using DPPH radical scavenging assay. Results showed that according to the Lf concentration used different properties were obtained. Nanoemulsions with Lf concentrations between 2 and 5% (w/w) presented sizes around 160 nm and a ζ-potential higher than +30 mV. For concentrations below 2 % (w/w), nanoemulsions presented sizes around 200 nm and a ζ-potential bellow +30 mV. It was noticed that higher Lf concentrations lead to smaller sizes and higher ζ-potential values. By increasing the Lf concentration was observed a decrease on superficial tension of nanoemulsions. TEM measurements showed that nanoemulsions particles have defined spherical shape. Results also showed that nanoemulsions with Lf concentration above 2 % (w/w) present better properties (smaller sizes and higher ζ-potential) so the storage stability of these nanoemulsions were assessed. Nanoemulsions stored at 4 ºC did not exhibit significant variations in size and ζ-potential values, while at 25 ºC the nanoemulsions suffered an size increase (around 35 nm compared to initial value) and a reduction in ζ-potential (around 20 mV compared to initial value) during storage. At these conditions, it was also observed that nanoemulaions with Lf concentrations of 2 and 3 % (w/w) present an instability (variations of size and ζ-potential) after 14 days of storage at 25 ºC, while for higher Lf concentrations (4 and 5 % (w/w)) the changes only start to be noticed latter (after 29 days of storage). Antioxidant activity did not demonstrate significant changes before and after storage at both temperatures (IC_{50} was around 14 mg/g of solution). This work provides important information that can be useful for the design of nanoemulsions aiming the encapsulation of lipophilic compounds for pharmaceutical and food applications.