Encapsulation of omega-3 fatty acids in bio-based nanoemulsions: physical and chemical characterization

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The use of nanotechnology can offer 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 positively influence 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 their direct application in foods extremely difficult. Nanoencapsulation (through nanoemulsions) may be used to reduce these problems.
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 using dynamic light scattering (DLS) and by surface tension using the Ring method. The morphology of nanoemulsions was 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 evaluated by antioxidant activity measurements using the 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 below +30 mV. It was noticed that higher Lf concentrations lead to smaller sizes and higher ζ-potential values. Increasing Lf concentrations caused a decrease in the superficial tension of nanoemulsions. TEM measurements showed that nanoemulsions particles have a defined spherical shape. Results also showed that nanoemulsions with Lf concentration above 2 % (w/w) present better properties (smaller sizes and higher ζ-potential) regarding their storage stability. Nanoemulsions stored at 4 ºC did not exhibit significant variations in size and ζ-potential values, while at 25 ºC the nanoemulsions suffered a size increase (of around 35 nm compared to the initial value) and a reduction in ζ-potential (of around 20 mV compared to the initial value) during storage. Antioxidant activity did not demonstrate significant changes before and after storage at both temperatures (IC50 was around 14 mg/g of solution).