Chitosan films as a carrier of omega-3 loaded nanoemulsions: physic-chemical characterization and release behaviour on different food simulants

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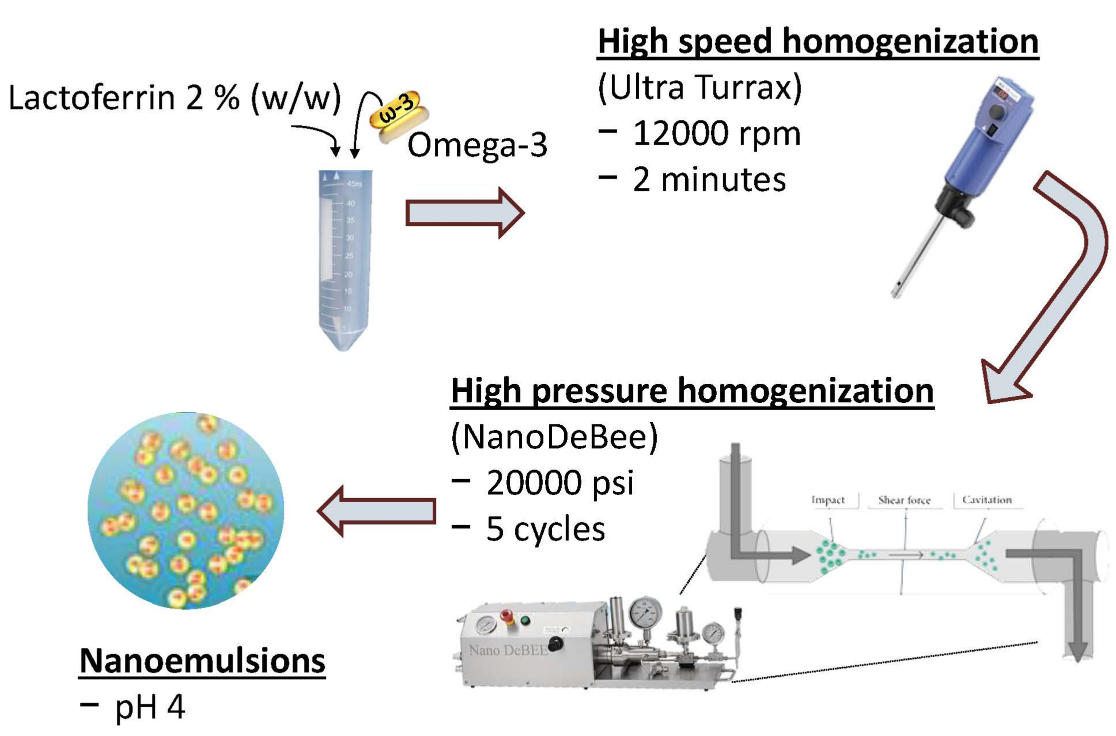
Introduction

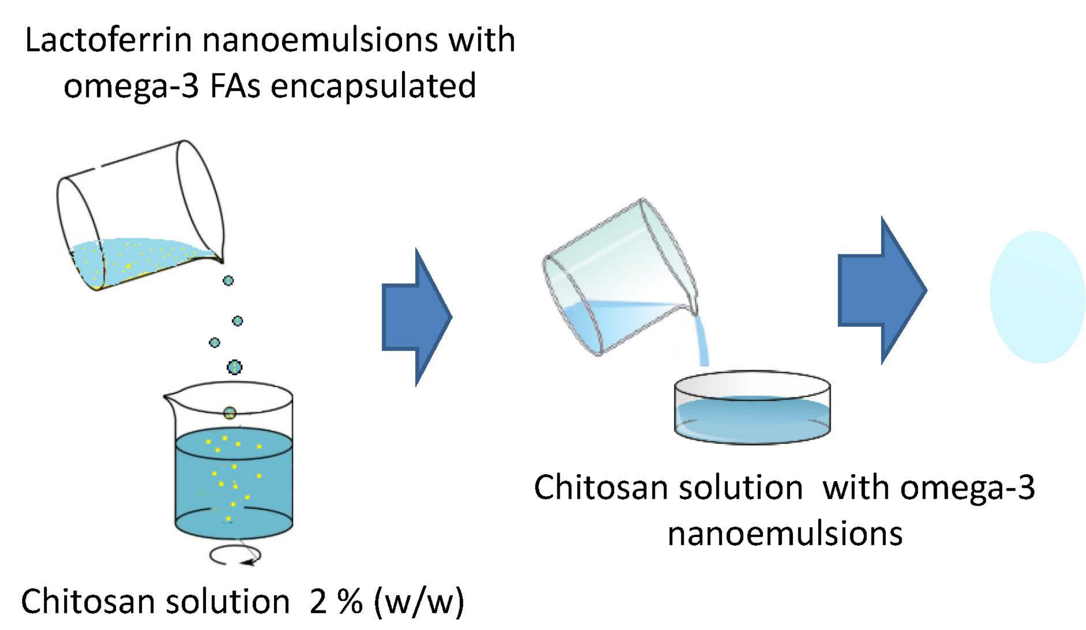
Bio-based and biodegradable films loaded with active compounds can be used as an alternative to improve the shelf life of food products and add nutritional value to food. Omega-3 polyunsaturated fatty acids (omega-3 FAs) are known for their functional properties (e.g. improve cardiovascular health, improve cognitive function and decrease inflammation). However omega-3 FAs is highly susceptible to oxidation which makes their direct application in foods extremely difficult. To improve its application in food products and protect against oxidation, nano-sized emulsions emerge as a viable alternative. Lactoferrin nanoemulsions containing omega-3 FAs were incorporated in chitosan-based films and evaluated in terms of physic-chemical properties (water vapour permeability, solubility and mechanical tests). Moreover, the release behaviour of omega-3 FAs from chitosan films were studied in a lipophilic and hydrophilic release medium at 25 °C in order to predict their behaviour in food matrices. The main aim of this work was developing an active packaging to increase nutritional value of food products.

Materials and Methods

• Nanoemulsions Production



• Nanoemulsions loaded to chitosan edible films



• Physic-chemical characterization and release properties

Results and Discussion

• Nanoemulsions Characterization

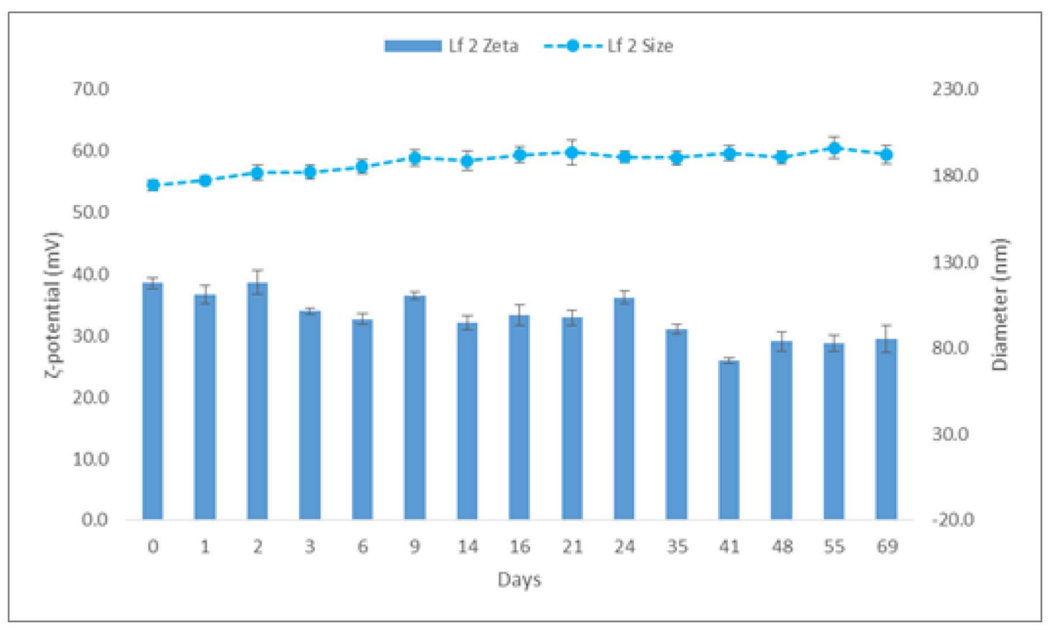


Fig. 1 Size and ζ- potential of omega-3 nanoemulsions produced with 2 % (w/w) of lactoferrin stored during 69 days at 4 ºC

- ❑ Nanoemulsions stored at 4 ºC did not exhibit significant variations in size and ζ-potential values.
- ❑ Nanoemulsions with 2 % (w/w) of lactoferrin presented sizes around 160 nm and a higher than +30 mV ζ-potential.
- ❑ TEM measurements showed that nanoemulsions droplets have spherical shape (Fig. 1).

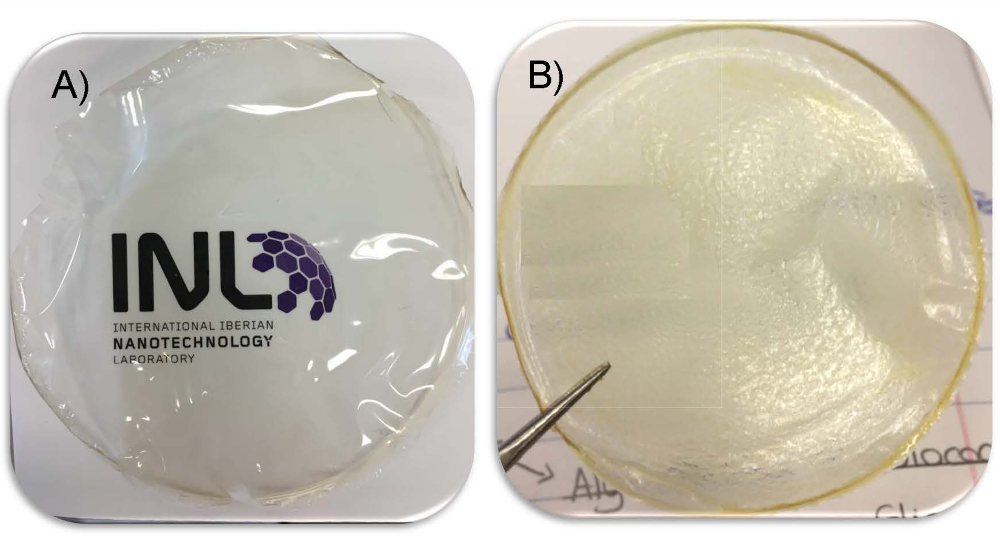


Fig. 2. Influence of incorporation of omega-3 nanoemulsions in optical properties of chitosan edible films: **A)** chitosan edible films and **B)** chitosan with omega-3 nanoemulsions encapsulated.

• Physic-chemical characterization and release properties of films

Table 1. Physic-chemical properties of chitosan edible films with omega-3 nanoemulsions

	WVP (g/Pa.s.m2)	Moisture (%)	Solubility (%)	Thickness (mm)	TS (MPa)	E (%)
Chitosan	$2.41 \times 10^{-10} \pm 9.42 \times 10^{-12}$	40.02 ± 0.81	38.12 ± 0.27	0.108 ± 0.012	12.12 ± 2.02	79.33 ± 1.09
Chitosan with omega-3 nanoemulsions	$2.19 \times 10^{-10} \pm 2.10 \times 10^{-11}$	23.12 ± 0.25	22.09 ± 013	0.079± 0.156	8.23 ± 1.25	132 ± 0.98

- ❑ The addition of omega-3 nanoemulsions affected barrier properties: a decrease in water vapour permeability was observed with the incorporation of bio-based nanoemulsions.
- ❑ A decrease was observed for moisture values of chitosan edible films with nanoemulsions
- ❑ Water affinity measurements showed that chitosan edible films with nanoemulsions are more hydrophobic and consequently less water soluble.
- ❑ The addition of omega-3 nanoemulsions to chitosan films affected the mechanical properties: caused a reduction of tensile strength and an increase of elongation.

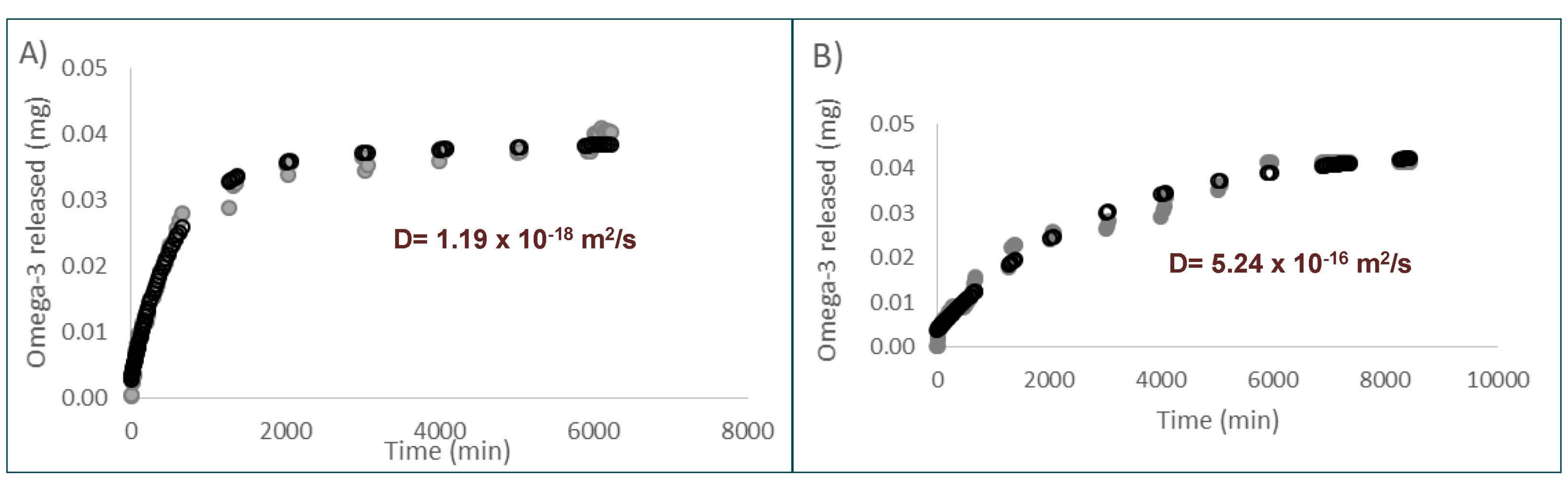


Fig. 3. Profile of omega-3 release from chitosan edible films at hydrophilic medium (10 v/v % ethanol) **(A)** and lipophilic medium (50 v/v % ethanol) **(B)**l; experimental data (•); Linear Superimposition Model (i = 1) (○).

Conclusion

Results showed that it is possible to incorporate omega-3 nanoemulsions in edible films; this work contributes to the establishment of an approach to optimize edible films after the addition of nanostructures promoting new and enhanced functionalities of packaging materials.

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