
The effect of spray-drying and freeze-drying on encapsulation efficiency, and oxidative stability of ω -3 rich oil in water nanoemulsion during storage

SEMENOGLOU I. (1), KATSOULI M. (1), TAOUKIS P. (1)

1 Laboratory of Food Chemistry and Technology, School of Chemical Engineering, National Technical University of Athens, Athens, Greece

ω -3 polyunsaturated fatty acids (PUFA) intakes rise globally as they confer significant health benefits. Fish oil represents 2% of total fats and oil consumed worldwide since both fish and fish discards are rich in PUFA which can be recovered and used as bioactive ingredients fortifying food products. The efficient valorization of fish side streams by extracted PUFA, can play an important role in the circular economy improving economic and environmental sectors, as 35% of the global food losses and waste arrive from fish by-products. However, PUFA are highly susceptible to oxidation, leading to the formation of volatile products with unpleasant smell and taste. Nanoemulsion-based delivery systems can protect hydrophobic compounds from oxidation and facilitate their incorporation into foods, supplements and pharmaceuticals while release them at an appropriate site within the gastrointestinal tract. In order to overcome the limitations of liquid-base delivery system, this study aims to evaluate spray- or freeze-dried ω -3 nanoemulsion powders in terms of encapsulation efficiency and oxidation stability.

Oil-in-water nanoemulsion systems were created using two-step homogenization with 10% wt fish oil rich in ω -3 PUFA and 10% wt whey protein or Tween 80. Fish oil nanoemulsion powders were prepared using spray-drying or freeze-drying with mixtures of maltodextrin (5%-30% wt) with 1% alginic acid or 10% Arabic gum as wall material. The physicochemical characters of nanoemulsions (liquid base, powders) were determined using DLS, FTIR and SEM analysis. Encapsulation yield and lipid oxidation were determined at various storage conditions (20-60°C, 11-55% RH).

ω -3 rich nanoemulsions with transparent appearance and low droplet size (<200nm) were prepared. Both drying methods are equally capable for producing nanoemulsions powders with satisfactory encapsulation yield, (>85%). The mixture of 20% wt maltodextrin and 10% wt arabic gum resulted in nanoemulsion powders with the highest encapsulation yield (90%) while inhibit oxidation during storage at different temperature and RH%.

ω -3 nanoemulsion powders with high storage stability are suitable for functional food products protecting PUFA for oxidation while increasing ω -3 intake and bioavailability.

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