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Nanoemulsions stabilized by caseinates as potential controlled delivery vehicles of interest in dermatological and cosmetic products

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Abstract – O/W and W/O emulsions consisting of isopropylmyristate and water compatibilised by interfacially active species, namely, caseinates and oleic-20-etoxyalcohol, were prepared by the phase inversion temperature technique (PIT) and by a more conventional procedure that does not involve the heat shock. The effect of sample and procedure variables on the emulsion morphological and rheological features has been investigated through a 2^{15-11} factorial experimental design. Rheological behavior revealed dynamic distinctions of emulsions, suggesting discrepancies in structural features, as a dependence of sample composition and preparation methodology.

Nanoemulsions are self-assembled structures of interest in different instances of pharmaceutical and cosmetic segments due to their enhanced capabilities as carriers of drugs, active compounds and possibilities of controlled release. The use of amphiphylic proteins, such as those found in the casein family, as emulsifiers, can be an interesting novelty in the development of these formulations due to both caseinate´s notable interfacial activity [1] and to the appeal brought about by the use of natural products in formulations for medical or cosmetic use. Besides their good sensory qualities, lack of toxicity or any harmful effects can also contribute to a better acceptance by the user or patient. To date, the development of protein stabilized emulsions, and in particular nanoemulsions, are significantly less addressed than would be expected, considering the advantageous aspects mentioned above.

Emulsions are thermodynamically unstable preparations. Being able to control the kinetic stability (or metastability) of samples in order to conform with shelf-life times and other requisites of use has been, therefore, one of the main goals of this study. Proteins can be a promising addition to this respect, since their inherent rheological characteristics, such as higher viscosity, may retard disturbing events such as droplet coalescence and sedimentation. Regarding, specially, their potential utilization in cosmetics, protein-based formulations present interest in skin and hair care products due to properties, like: skin and hair substantivity, conditioning action and film forming (which may contribute with skin hydration), among others.

In this work, an attempt has been made to investigate the development of casein-stabilized emulsions, aiming at the obtention of droplets containing the internal phase in the nanoscale size (20-200nm). For developing nanodroplets, the literature refers the use, of at least, three main kinds of procedures: a) mechanical constrictions at high pressures; b) ultra-sound; c) heat shock. In this work, the latter was applied, through the phase inversion temperature (PIT) method. A more conventional procedure of emulsion preparation was also employed, for comparison purposes. The experimental approach comprised a 2^{15-11} factorial design [2].

For the application of the PIT method [3], emulsions were prepared by the gradual heating of samples under stirring until the critical temperature was achieved, followed by immersion in ice bath. Phase inversion was followed conductimetrically. Macroscopic aspect of samples, evolving from opaque towards slightly opalescent, was the first indication of the adequacy of the technique for the desired purpose. Both oil in water (O/W) and water in oil (W/O) emulsions were studied. Rheological patterns of response quite differed between the two groups of sample, with Newtonian flow being observed in the former and pseudoplasticity in the latter. For one same kind of emulsion, (O/W or W/O), apparent droplet size and rheological profiles were found to depend on the preparation technique employed. The kinetic stability of emulsions, as assessed by established standard methods, was found to bear a dependence on the preparation procedure and sample composition. Light scattering measurements for the characterization of the emulsion droplet average size and distribution, through the determination of their hydrodynamic radii, are in course.

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