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Systematic characterization of oil-in-water emulsions for formulation design

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Abstract

Oil-in-water emulsions varying in surfactant concentration and manufacturing process were prepared. About 10 experiments were performed to characterize them. The goal of this research was to find out which tests should systematically be carried out to assess efficiently the stability and the properties of an emulsified preparation. Thus, formulation design requires at least the measurement of the droplet size, the determination of the zeta potential, a TurbiScan® analysis, the investigation of the stability under centrifugation and freeze/thaw cycles. If the emulsion contains an active substance, stability under storage at 4 °C and microscopic analysis are relevant. Quality control should be improved by measurements of viscosity and pH.

Keywords: Emulsion; Characterization; Stability; Size

1. Introduction

Oil-in-water (o/w) emulsions are commonly formulated for parenteral and topical administration but also for oral and ocular routes (Tamilvanan et al., 2001; Vandamme, 2002). Each route of administration has to meet its own requirements of formulation, e.g. sterility for parenteral preparations, aesthetic attractiveness for topical products. Another interesting point for emulsions is the size of the droplets of oil dispersed in the water. The median size (Chanana and Sheth, 1995; Prinderre et al., 1998) as well as the distribution of sizes (Liedtke et al., 2000) are very important since they determine the safety of the preparation in the case of intravenous preparations (Mbela and Ludwig, 1995) or the release properties of the active ingredient in topical formulations (Friedman et al., 1995). Nevertheless, all emulsions should first be considered as dispersed systems and overall analyzed in terms of stability. Stability is often related to the zeta potential (ζ) of the system. Its value reflects the stability of the dispersed system in a chosen environment but gives poor information about the stability over time: how will the preparation age? Creaming, coalescence, flocculation, phase separation, rupture, Ostwald ripening may occur in emulsified systems (Welin-Berger and Bergenståhl, 2000), leading to numerous instability processes. In flocculation, two droplets become attached to each other but are still separated by a thin film of liquid. When more droplets are involved, an aggregate is formed, in which the individual droplets cluster together but retain the thin liquid films between them. The emulsifier molecules remain at the surface of the individual droplets during this process. When the thin liquid film between the droplets is removed, bigger droplets can be formed and coalescence can

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