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Abstract

A Stability Evaluation of a *Nigella sativa* Essential Oil Fine Emulsion Containing Sodium Lignosulfonate as the Aqueous Phase †

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Thymoquinone, the main bioactive ingredient of *Nigella sativa* essential oil, is known to have important antioxidant, antimicrobial and anti-inflammatory properties [1]. It has also been proven to reduce induced stress in Lens culinaris seeds, making it ideal as a plant biostimulant [2]. Since the next generation of these types of biostimulants should ensure the slow release of the active ingredient due to the phytotoxic effects that are possible at high concentrations, encapsulation in a delivery system, such as through the use of emulsions, yields promising perspectives [3]. This study explores the stability of fine emulsions using sodium lignosulfonate and coconut oil containing *Nigella sativa* essential oil as possible delivery systems for thymoquinone. For the preparation of the emulsion, *Nigella sativa* and *Thymus vulgaris* essential oils were purchased from Solaris (Bucharest, Romania), fractionated coconut oil (medium chain triglycerides) was obtained from Mayam (Elemental, Oradea, Romania) and the anionic surfactant Tween 85 was purchased from MP Biomedicals (Ohio, USA). The sodium lignosulfonate (NaLS) stream was obtained from The Cellulose and Paper Manufactory—CCH (Mehedinți, Romania). The emulsions were prepared using a method described previously by Ostertag [4] consisting of titrating the aqueous phase containing sodium lignosulphonate solution to an organic one combining fractionated coconut oil, *Nigella sativa* essential oil and Tween 85 as the surfactant under constant stirring. To assess the stability of the emulsions, droplet size was measured immediately and after a 24 h period following their preparation using Dynamic Light Scattering (DLS). The measurements were performed using an Amerigo Particle Size & Zeta Potential Analyzer (Cordouan Technologies, France). The samples were diluted a hundredfold in water, and the measurements were conducted at room temperature at an angle of 135 degrees by utilizing the DTC head. Data analysis was carried out using Amerigo Software employing the Cumulant Algorithm. Visual investigations were also performed. The stability was dependent on various parameters, which are ranked as follows: (1) the surfactant hydrophilic–lipophilic balance (HLB) value, with no phase separation observed for a HLB value of 11, corresponding to the surfactant Tween 85; (2) the NaLS concentration in the aqueous phase, with the smallest droplet size variation at the lowest NaLS concentration without visible phase separation; (3) the oil phase composition, where equal parts of *Nigella sativa* and *Thymus vulgaris* essential oils yielded the most stable emulsion; (4) reaction time, all emulsions were stable, with the smallest droplet size being achieved at a 60 min. reaction time. The formulation with low NaLS concentration in the aqueous phase and an organic phase containing medium-chain triglycerides, equal parts of *Nigella sativa* and *Thymus*

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vulgaris essential oils, and Tween 85 as the surfactant produced droplets with a diameter size variation from 141 nm to 156 nm in 24 h, which is considered small enough not to destabilize the system.

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