

## The Performance of the *Ruta montana L.* Essential Oil Bisulfite Adduct as Mixed Natural Emulsifier and a Comparison with Single Tailed Surfactant

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### ABSTRACT

The aim of the present study is the use of *Ruta montana L.* essential oil consisting mainly of aliphatic ketones (93%) of variable chains length ( $C_9$ - $C_{13}$ ) as a raw material for the synthesis of a natural emulsifier. The *Ruta montana L.* essential oil in water emulsions, were prepared using sodium 2-hydroxyundecane-2-sulfonate (SHUS) as a single bifunctional anionic-nonionic surfactant and mixed sodium 2-hydroxyalkyl-2-sulfonate (MSHAS) as a mixture surfactant containing different alkyl chains length, obtained by the action of sodium hydrogenosulfite aqueous solution on the 2-undecanone and the *Ruta montana L.* essential oil respectively. The synthesized surfactants were characterized by Fourier transform infrared Spectroscopy (FTIR), nuclear magnetic resonance spectroscopy NMR ( $^1H$ ,  $^{13}C$ , APT, HSQC) and thermogravimetric analysis (TGA). The synergistic effect of the mixture surfactant on the surface tension, emulsion morphology, droplet size distribution, viscosity and stability with time of emulsions was investigated. Critical micelle concentration (CMC) values obtained by surface tension and conductivity measurement were respectively 1 mM and 0.8 mM and the surface tension at CMC,  $\gamma_{CMC}$  were  $47.4 \text{ mN.m}^{-1}$  and  $39.6 \text{ mN.m}^{-1}$  for the model surfactant and the mixture respectively. The adsorption efficiency of the surfactants at the surface was very important in particular for the emulsions prepared from the surfactant mixture. The non-Newtonian and viscoelastic behavior of the prepared emulsions were directly related to the significant increase of their viscosities resulting from the decrease of the droplets size characterized by Dynamic Light Scattering (DLS) with values of 418.3 nm and 376 nm for the model surfactant and the mixture.

### ARTICLE HISTORY

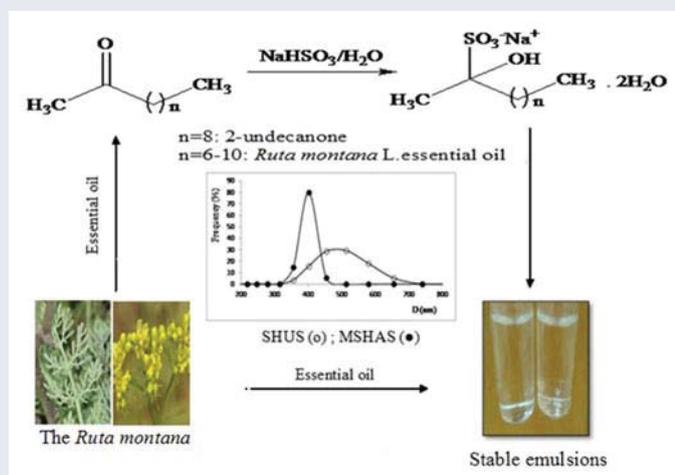
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### KEYWORDS

*Ruta montana L.*; Essential oil; synergism; natural surfactant; emulsion stability

### GRAPHICAL ABSTRACT



### Introduction

The use of essential oils in low doses requires their solubilization in an aqueous media using an emulsifying agent. In addition of the toxicity of the synthetic surfactants in particular the nonionic surfactants, namely the Triton X-100

and the Tween 80, problems of instability of these formulations and the non reproducibility of their applications were met. These disadvantages can be remedied by the use of natural surfactants obtained directly from a natural source, animal or vegetal. These surface agents are responded poorly,