

PH EFFECT ON VISCOELASTIC BEHAVIOR AND PHYSIOCHEMICAL PROPERTIES OF WALNUT OIL EMULSIONS

M. KOWALSKA¹, A. KRZTON-MAZIOPA^{2*}

¹ Faculty of Material Science, Technology and Design, Kazimierz Pulaski University of Technology and Humanities, Malczewskiego 29, 26-600 Radom, Poland

² Faculty of Chemistry, Warsaw University of Technology, Noakowskiego 3, 00-664 Warsaw, Poland

* Corresponding author: anka@ch.pw.edu.pl
Fax: x48.22.6282741

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ABSTRACT:

The influence of pH of walnut oil emulsions on droplet morphology, droplet size distribution, time and temperature stability, and rheological properties has been studied. It has been found that walnut oil based emulsions form a metastable gel-like microstructure at steady conditions revealed by a linear viscoelastic response at low deformations. Flow curves of investigated emulsions demonstrated shear thinning behavior at moderate shear rates with a tendency to a limiting viscosity at higher loads. The most stable emulsion was formed at weakly acidic conditions (pH = 6), which favors the formation of fine uniform droplets with no visible tendency to coagulation at ambient conditions.

KEY WORDS:

emulsion stability, viscoelasticity, viscosity, shear thinning, pH effect, droplet morphology

1 INTRODUCTION

Emulsions usually consisting of two or more liquid immiscible phases are thermodynamically unstable systems prone to phase separation driven by tendency to minimization of the interfacial area between the aqueous and the oil phase. Since many years they are among the most important colloids in numerous applications in the food, cosmetics and pharmaceutical industries [1, 2]. In many cases the emulsion contains also a surface active agent, which has two main functions: the first one is to decrease the interfacial tension between phases; thereby enabling easier formation of the emulsion; and the second one is stabilization of the dispersed phase against coalescence once it is formed. Emulsions can be classified into two broad groups: simple emulsions and multiple emulsions. In the case of simple emulsions, droplets of one liquid phase are dispersed in another immiscible continuous phase [2]. Beside such emulsions there are double emulsions described as "emulsions of emulsions" [3]. For example, an oil-in-water-in-oil (O/W/O₁) double emulsion consists of small oil (O) droplets dispersed in aqueous phase (W) and this O/W emulsion itself is dispersed as large droplets in the continuous oil phase (O₁). In the case of a water-in-oil-in-water (W/O/W₂) double emulsion, an emulsion of small water (W) droplets in oil

(O) is itself dispersed as large droplets in the continuous aqueous (W₂) phase [3].

Emulsions are metastable systems and their initial structure evolves with time during storage and/or transportation as a result of thermal treatments, mechanical stresses, physical coarsening and biological action [4]. Thus, the main challenge raised by the application of emulsions is their thermodynamic instability. Indeed, they are prone to destabilization and phase separation. During emulsification, the interfacial area between the continuous and the dispersed phases is considerably augmented compared to the interface before homogenization. The interfacial free energy is therefore significantly increased. According to thermodynamics all the metastable systems develop to attain their minimum energy state, which in the case of emulsions is manifested by a great tendency to phase separation in order to minimize the interfacial contact area and free energy. This instability manifests itself by various mechanisms: flocculation, coalescence, creaming or sedimentation, and Ostwald ripening [5]. Emulsion stability and rheological behavior is related to several factors such as volume fraction and viscosity of the dispersed phase, droplet granulometry, viscosity of the continuous phase as well as its chemical composition (polarity, pH), nature and electrolyte concentration, and interfacial rheology.