Rheological Characterization of Whey Protein-Stabilized Red Palm Oil (RPO) Emulsions

Vallerina Armetha[a], Purwiyatno Hariyadi[a,b,*], Azis Boing Sitanggang[a], Sri Yuliani[c]

[a] Department of Food Science and Technology, Faculty of Agricultural Engineering and Technology, IPB University, Bogor 16680, Indonesia
[b] Southeast Asian Food and Agricultural Science and Technology Center, IPB University, Bogor 16680, Indonesia
[c] Indonesian Center for Agricultural Postharvest Research and Development, Indonesian Agency for Agricultural Research and Development, Bogor 16122, Indonesia
[*] Corresponding author: phariyadi@apps.ipb.ac.id

Abstract

Whey protein-stabilized emulsion potentially may be used as a carrier system for a micronutrient-rich red palm oil (RPO). This study aims to investigate the rheological properties of the whey protein-stabilized RPO emulsions as affected by the type and concentration of whey proteins. The RPO emulsions were prepared using three types of whey protein (*i.e.*, WPCa, WPCb, and WPI) at four levels concentration (*i.e.*, 2.5, 5, 10, and 15% w/v) to carry 30% (v/v) oil phase. The emulsification was carried out by two-steps rotor-stator homogenization. Rheological characterization was done using Modular Compact Rheometer 92, Anton Paar GmbH. Parameters studied were the flow behavior, viscoelastic properties, apparent viscosity, and linear viscoelastic range limit of the emulsions. The results showed that type and concentration of whey protein affect the rheological characteristics of the emulsions. All of emulsions produced exhibit shear-thinning flow behavior and predominantly have viscous properties. The resulting emulsions can be characterized according to the Casson fluids behavior, except for the emulsion stabilized with 15% WPCa and 15% WPCb which better explained using the Herschel-Bulkley fluids behavior. Based on its limit of the linear viscoelastic region, the RPO emulsion stabilized with 15% WPCb considered to have the best physical stability, which is in accordance with our visual observation on the physical stability. The RPO emulsion stabilized with 15% WPCb can be described by the Herschel–Bulkley model, characterized by consistency coefficient (K) of 0.4392 Pa.s, Herschel-Bulkley flow behavior index (*n*) of 0.6960, apparent viscosity (η_{app}) of 101.28 ± 13.98 mPa.s, and linear viscoelastic limit (LVE) of 7.9%. Further research is needed to investigate the more detail rheological characteristics including the thixotropic test (time-dependent behavior), thermal stability test (temperature-dependent behavior), and hysteresis test, especially to understand its relationship with its physical stability.

Keywords: rheology, Casson fluid, Herschel-Bulkley fluid, emulsion stability, linear viscoelastic (LVE) range