Botanical Extracts in Water-in-Oil Emulsions: A Natural Strategy to Enhance Sunflower Oil Oxidative Stability

Giulia Potenziani [a], Virginia Teresa Glicerina [a], Vladimiro Cardenia [a], Vito Verardo [b], Silvia Molino [c], Julia Maldonado-Valderrama [d], Teresa del Castillo-Santaella [d], Pedro Jesús García-Moreno [e]

[a] Department of Agricultural, Forest and Food Sciences, University of Turin, Largo Paolo Braccini, 2, 10095, Grugliasco, Turin, Italy
[b] Department of Nutrition and Food Science, University of Granada, Campus of Cartuja, 18071, Granada, Spain
[c] Silvateam Spa, R&D Unit, San Michele Mondovì, Italy
[d] Department of Applied Physics, University of Granada , Campus de Fuentenueva sn, 18071, Granada, Spain
[e] Department of Chemical Engineering, University of Granada, Campus de Fuentenueva sn, 18071, Granada, Spain

giulia.potenziani@unito.it

Natural compounds are well known for their strong antioxidant properties; however, their hydrophilic nature limits their direct application in fats and oils, where oxidative degradation is a major concern. To overcome this problem, water-in-oil emulsions offer a promising strategy, improving the dispersion of these bioactive compounds in lipid environments but also enhancing their ability to inhibit oxidative processes at the oil-in-water interface, where oxidation generally starts. This study evaluated a plant-based extract to improve the oxidative stability of sunflower oil during a 2 weeks storage period at 45°C. The extract (0.06%) was firstly solubilized in 0.6% of water and then incorporated into the oil, and it was compared with BHT (0.02%), in accordance with the permitted level in edible oils, and with synthetic α-tocopherol (0.6%). Emulsions were preprared by mixing oil, 0.6% water and 1% polyglycerol polyricinoleate (PGPR) emulsifier. Antioxidant efficacy was assessed by monitoring the peroxide value (PV), conjugated dienes/trienes formation, and Rancimat stability; while physical stability was examined by evaluating changing in particle size distribution and turbiscan analysis. Regarding lipid oxidation, both the natural extract and BHT effectively counteracted oxidation compared to the control, whereas tochoperol exhibited a proooxidant effect. Indeed, at the end of the 14 days of storage, the peroxide value of the control reached 13.88 ± 0.09 meq O_2/kg, while BHT and the extract limited it to 7.18 and 8.28 meq O_2/kg, corresponding to a reduction of hydroperoxides by 48% and 40%, rescpectively ($p < 0.001$). Tocopherol, in contrast, showed a 13% increase of PV. Similar trends were observed for conjugated dienes and trienes, where BHT and the natural extract significantly delayed their formation ($p < 0.001$). Rancimat analysis confirmed these findings, as samples enriched with BHT and the natural extract desplayed significantly higher induction time ($p < 0.05$), confirming greater oxidative stability compared to the control. Regarding the physical stability, no significant differences in droplet size where observed between samples. Additionally, according to the Turbiscan Stability Index (TSI), all emulsions resulted stable during the first week of storage, showing only minor and reversible phase separation under thermal stress. However, during the second week, all samples lost stability, with the disappearing of the characteristic water-in-oil emulsion opalescence and the systems appearance of a transparent oil phase. Overall, the obtained results suggest that also hydrophilic extracts present a promising natural alternative to synthetic antioxidants for enhancing oil quality and reducing lipid oxidation, however a deeper investigation on the stability of the system has to carried out.

Keywords:
Natural Extracts, Oxidative Stability, Water-In-Oil Emulsions