

Case Study

OXIDATIONS IN LIPID EMULSIONS

OVERVIEW

Triglycerides contained in lipid emulsions (LE) are susceptible to oxidation. Exposure to high temperature and process pressure as well as atmospheric oxygen during the manufacturing of emulsions can deteriorate the quality by oxidation of double bonds. LEs are produced by high-pressure homogenization. The use of a backpressure module during homogenization alleviates the pressure drop from the process pressure up to 2000 bar back to atmospheric pressure at the outlet. Different cooling systems

are used to compensate for the development of heat during compression of the emulsion.

Our aim was to examine the influence of the installation of a backpressure module and two different cooling systems on the formation of oxidation products in lipid emulsions.



“ We produced 60 new emulsions that we evaluated right after manufacturing as well as after autoclaving. The ShearJet HL60 makes running such a large number easy, and we have complete faith in the integrity of the equipment and therefore the outcome of our research.

Gregory Holtzauer, ETH Zurich

METHOD

LEs containing either 20% soybean or 10% fish oil were homogenized for six cycles at a process pressure of 22 kpsi, using the Dyhydromatics ShearJet® HL60 high-pressure homogenizer (HPH). To investigate the effect of the backpressure module, as well as the cooling system, the droplet size was measured and the primary and secondary oxidation products of the LE were quantified with established assays namely the modified ferrous oxidation xylenol orange assay [1] and the thiobarbituric acid reactivity assay [2]. The assays were adapted to work with minimal sample amount and optimized for high throughput in a microplate reader setup. The results of the produced LEs were compared to readings from three commercially available reference emulsions, determined with the same assays.

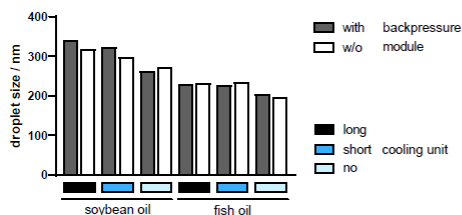


Fig. 1: Comparison of droplet sizes of different autoclaved emulsions manufactured using the backpressure module and without it (n=1)

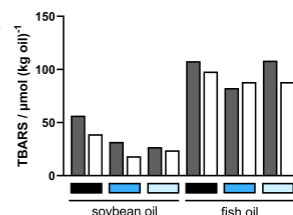


Fig. 2: Secondary oxidation products (measured by TBARS assay) of autoclaved emulsions to investigate the effect of the backpressure module on oxidation (n=1)

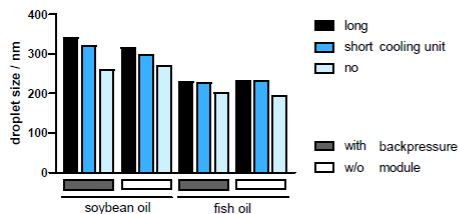


Fig. 3: Droplet size of the emulsions as a function of the used cooling system (n=1)

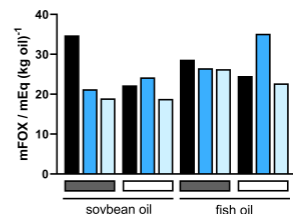


Fig. 4: Influence of the cooling system on primary oxidation products of emulsions right after manufacturing (n=1)

[1]DermişS, Can S, Doru B. SpectroscLett2012; 45: 359-365

[2]AlamedJ, McClementsDJ, Decker EA. Food Chem2006; 95:585-590

CHALLENGES

- 1 Oxydation deterioration of triglicerides
- 2 Machine set up- Would different type of cooling system and presence of backpressure module have an effect on the oxidation level of triglycerides?

SOLUTIONS

- 1 Using oils less prone to oxidation
- 2 Different machine set ups were tested and no significant differences that would have an effect on the oxidation of triglycerides were observed.

RESULTS

Backpressure and cooling during the high-pressure homogenization had marginal effects on primary and secondary oxidation products of the lipid emulsions. A trend towards smaller droplet sizes when omitting the cooling unit was detected. The main difference in droplet size and secondary oxidation products were assigned to the type of oil in the emulsion. Droplet size was smaller and secondary oxidation product levels were higher when fish oil was used instead of soybean oil. We are currently investigating the effect of the high-pressure homogenization itself on the oxidation of the lipids. Generally, no striking benefit of upgrading the standard ShearJet® HL60 setup with installation of a backpressure module or extending the cooling unit was found.

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