Comparison of Peroxide Value, Oil Stability Index and Chemiluminescence Oxidation Induction Time of Sunflower Oil

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Introduction

Lipid oxidation limits the shelf life of sunflower oil. A new approach to measure stability and oxidative status of the oil is Chemiluminescence, which refers to luminescence based on chemical reaction. During decay of peroxide radicals excited electrons relax into their thermodynamically preferred state which results in the emission of light. Emitted photons are counted by a photomultiplier tube.

Objectives

The goals of this study were to

- Compare CL with common methods like peroxide value and oil stability index
- Compare oxidative stability of sunflower oil and high oleic sunflower oil

Material and Methods

Sunflower oil and high oleic sunflower oil (Fig. 1) were submitted to an accelerated ageing process by storing the samples at 85°C in a water bath during 0.5, 1, 1.5, 2, 6, 24 and 48 h. Peroxide Value and Oil Stability Index OSI (Oxidative Stability Instrument, Omnion Inc., Massachusetts) were measured directly after ageing. For stability test with Chemiluminescence (CL) method 10µl of a sample was placed in a basic configuration instrument from ACL instruments (Fig. 2) and measured at isothermal conditions (130°C) under synthetic air.

10%	Saturated fatty acids (SFA)	10%
30%	Mono-unsaturated fatty acids (MUFA)	80%
60%	Polyunsaturated fatty acids (PUFA)	10%

Fig. 1 Composition of conventional and high oleic sunflower oil used for trials

Fig. 2 Basic instrument configuration with the furnace cell and schematic view of the setup (ACL Instruments, CH-3210 Kerzers)

Results and Discussion

As expected high oleic sunflower oil was less susceptible to oxidation and thus had lower Peroxide Values and higher Oil Stability Indices (OSI) than common sunflower oil. Peroxide Values were more than twice as high for high oleic than for traditional sunflower oil (Fig. 3). Both oils seemed not to have reached the hydroperoxide content maxima even after 48h of treatment as there was still a linear correlation of treatment time and Peroxide Value.

For high oleic sunflower oil the Oxidation Induction Time (OIT) of Chemiluminescence (CL) decreased from 4.8 h for untreated oil to 2.2 h after 48 h of ageing. Common sunflower oil was already at the beginning less stable, thus OIT was at 1.5 h for untreated oil and 0.9 h after 48h of treatment.

Fig. 3:

Peroxide values (n=2) of high oleic and traditional sunflower oil depending on treatment time (85°C)

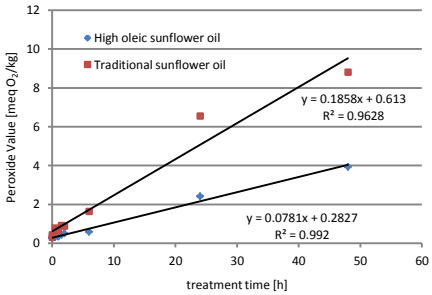

Figure 4 shows high correlations of Peroxide Value and OIT (CL) for both traditional sunflower oil (R^2 = 0.93) and high oleic sunflower oil (R^2 = 0.97). Oil stability index OSI and OIT were also comparable. While the Oil Stability Index OSI measures the formation of secondary oxidation products, Chemiluminescence detects the decay of primary oxidation products.

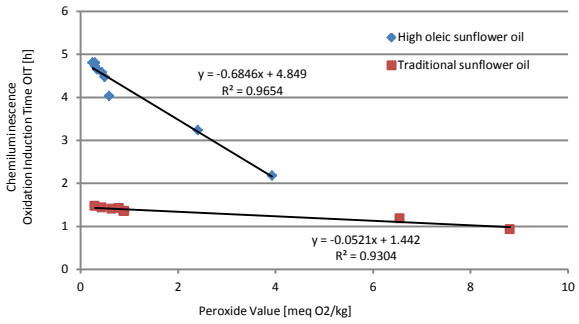

Fig. 4: Correlation of Peroxide Value (*n*=2) and Oxidation Induction Time of Chemiluminescence (isothermal @130°C, synthetic air, *n* = 3)

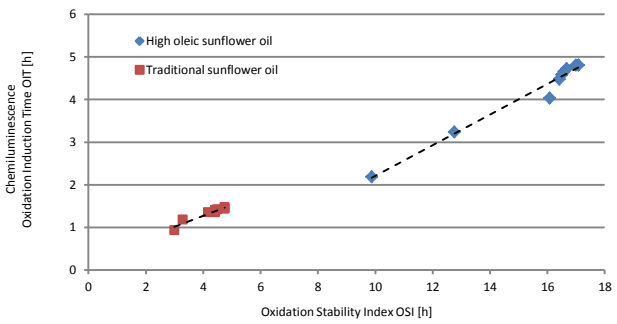

Fig. 5: Correlation of Oil Stability Index OSI (*n*=1-2) and Oxidation Induction Time of Chemiluminescence (isothermal @130°C, synthetic air, *n*=3)

Conclusions

Peroxide Value, Oil Stability Index and Chemiluminescence (CL) measurements confirmed as expected that high oleic sunflower oil had a lower susceptibility to oxidation than traditional sunflower oil. Peroxide value and OIT (CL) had high correlations for both sunflower oil (R^2 = 0.94) and high oleic sunflower oil (R^2 = 0.97). Oil Stability Index and OIT (CL) were also comparable. In conclusion Chemiluminescence allows to detect the presence of hydroperoxides (like peroxide value if measured under N_2 gas flow) with the benefit to predict oxidative stability like Oil Stability Index (if measured under synthetic air flow) but based on the detection of primary oxidation products. Thus there is a high potential of Chemiluminescence in monitoring and predicting oil quality as the results were highly correlated to peroxide value and the sample preparation is very simple.

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