Application of Rapid Oxidation Instruments in Quality and Oxidative Off-flavor Control in Food

Research and Development

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Background

RapidOxy, Oxitest, and Oxipres have gained increasing interest in both academia and industry for the prediction of oxidative stability of raw materials and foods because traditionally multiple time-consuming analyses including sensory are involved at real shelf-life storage conditions. The principles of accelerated oxidation by RapidOxy, Oxipres, and Oxitest are similar, and they measure the oxygen intake of the sample in a closed stainless-steel test chamber at elevated temperature and exposure to oxygen. The aim of this study is to determine the correlation of these rapid instruments to Rancimat analyses in oils and fats, and oxidative off-flavor in finished products.

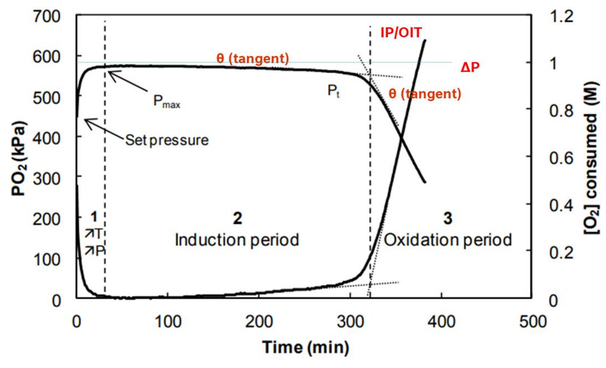


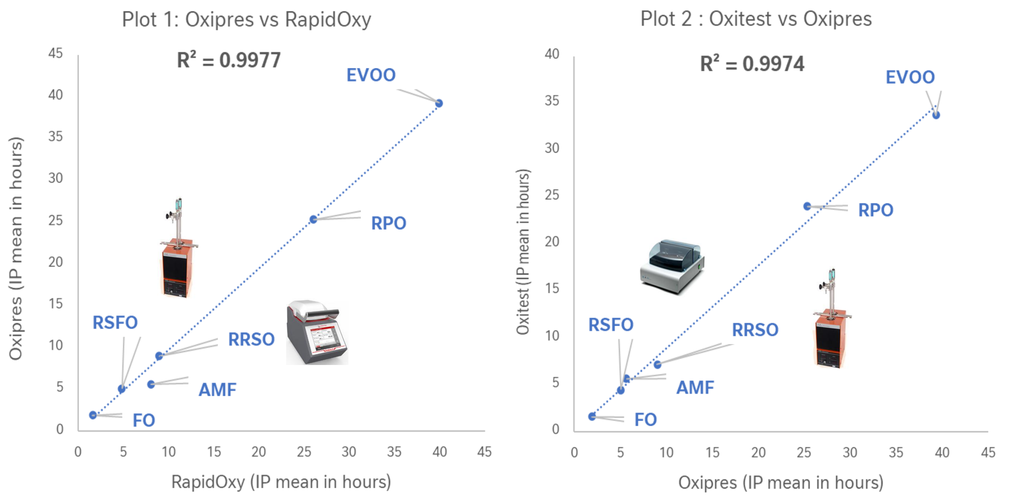
Figure 1: Principe of Rapid oxidation instruments[1] (with own adaptation).

Material and Method

Study 1 oils and fat samples: refined sunflower oil (RSFO), rapeseed oil (RRSO), palm olein (RPO), extra virgin olive oil (EVOO), fish oil (FO) and anhydrous milk fat (AMF).
Study 2 biscuits samples: fresh and aged biscuits made from soybean oil, and fresh biscuits made from palm oil with and without a compromised process condition.

Instruments:
Rancimat (Methrom, Switzerland): test portion 3g, temperature 100°C, airflow 20 L/h,
RapidOxy 100 (Anton Paar, Austria): test portion 2g, temperature 100°C, pressure 7 bar
Oxipres (Mikrolab Aarhus A/S, Denmark): test portion 5g, temperature 100°C, pressure 7 bar
Oxitest (Velp Scientifica, Italy): test portion 10g, temperature 100°C, pressure 7 bar.

Results and Discussion



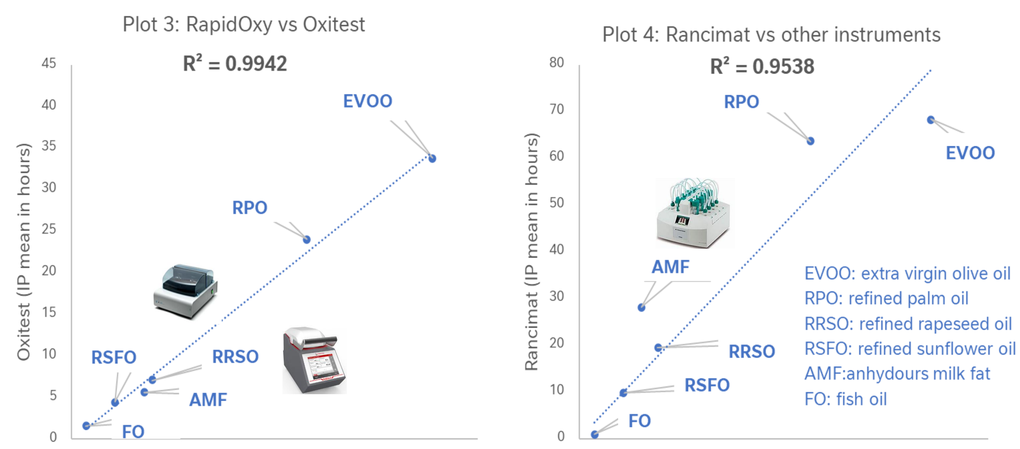


Figure 2: Comparison study of oils and fat by Rancimat (test portion 3g, 100°C, airflow 20 L/h), RapidOxy 100 (test portion 2g, 100°C, 7 bar, report on time needed to reach 10% pressure drop), Oxipres (test portion 5g, 100°C, 7 bar, report IP), and Oxitest (test portion 10g, 100°C, 7 bar, report IP).

- 6 partners and 8 instruments (2 Rancimat, 3 RapidOxy 100, 2 Oxipres, and 1 Oxitest) were involved in this study.
- A very good correlation (r=0.99) between RapidOxy, Oxitest, and Oxipres was found in oils and fats (Figure 2).
- A good correlation (r=0.95) was found with an IP ratio close to 2 between Rancimant and Rapid oxidation instruments for refined sunflower (2.0-2.2), and rapeseed oil (2.2-2.7).
- The lower IP ratios of fish oil (0.5-0.6) and extra virgin olive oil (1.7-2.0) need further confirmation at optimized temperature.
- The higher IP ratios of anhydrous milk fat (3.5-5.0) and refined palm olein (2.4-2.7) might be due to a higher concentration of saturated fatty acids.

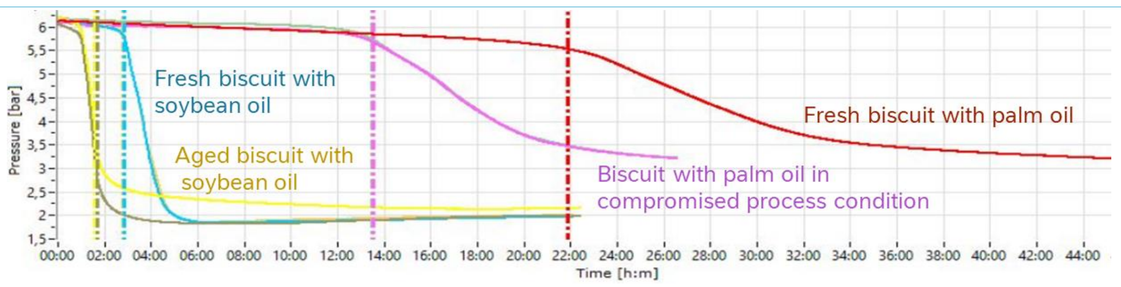


Figure 3: Biscuit off-flavor/taste prediction by Oxitest (test portion 30g, 110°C, 6 bar, report IP)

- Rapid oxidation instruments can detect the difference in oxidative stability in biscuits due to the oil type, aging stage, and process condition used (Figure 3).
- IP correlation with sensory evaluation or shelf-life needs to be validated for off-flavor or shelf-life prediction.

Conclusion

- Rapid oxidation instruments correlate well with Rancimat for most oils, exceptions made for animal fat or vegetable oils with high concentrations of unsaturated fatty acids.
- The prediction of the oxidative stability in raw materials and finished products needs to be correlate with real shelf-life oxidation analytics because the accelerated conditions (high temperature and oxygen pressure) might alter the oxidation kinetics, pathways, and formed oxidation products.

Reference:

[1]: *Guitard, R., et al. (2016). "Theoretical and Kinetic Tools for Selecting Effective Antioxidants: Application to the Protection of Omega-3 Oils with Natural and Synthetic Phenols." Int J Mol Sci 17(8).*