Application of the Oxitest® method to estimate the kinetic parameters in soybean oil under accelerated storage conditions

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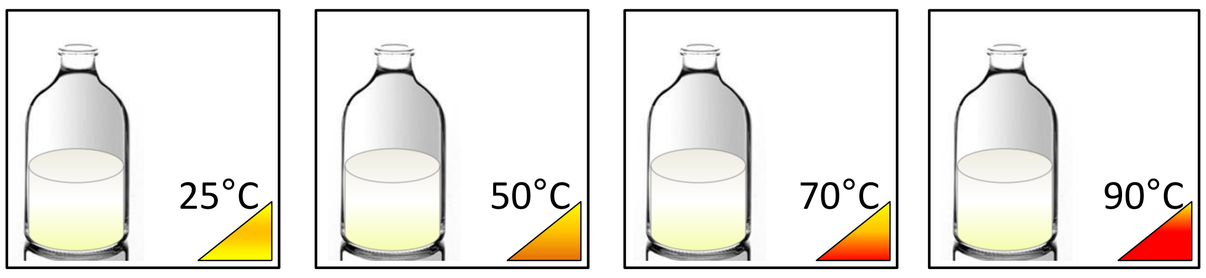
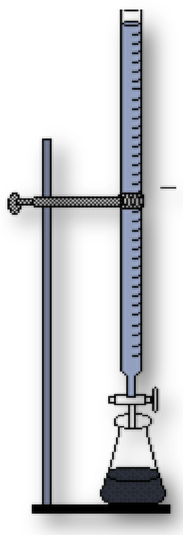
Introduction & aim

A number of accelerated methods have been developed to test the resistance of edible fats and oils to oxidation. All these accelerated methods involve the use of elevated temperatures because of the rate of the oxidative reaction is exponentially related to the temperature. Oxitest® reactor (Velp Scientifica, Usmate - MI) has been successfully used to measure the resistance to oxidation of vegetable oils and fatty foods. In spite of that, the measure of the oxidative degradation kinetics of food during shelf life represents the main goal for the complete development of the reactor. In order to assess this instrumental capacity a preliminary study was carried out comparing the Oxitest response (IP) with the traditional measure of the Peroxide Value (PV). Soybean oil was used as lipid matrix due to its high susceptibility to oxidation (high PUFA content) and was stored at different temperatures in opened glass bottles.

Material and Methods

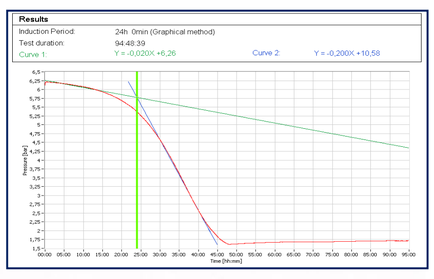




PEROXIDE VALUE
(PV - meq kg^{-1})

Regulation EC 2472/97

OXITEST
(IP - min)



Temperature = 90°C
Oxygen Pressure = 6 bar

For each temperature, the PV numbers of the vegetable oil and the IP values obtained from the Oxitest® were recorded and plotted against the storage time. The increase of the PVs and the decrease of IPs followed a zero order kinetic: therefore the reaction rate constant (k) for each temperature was simply estimated (**Table 1**).

Index	25°C	50°C	70°C	90°C
k(IP) h^{-1}	0,0603	0.092	0.676	1.817
k(PV) h^{-1}	0,0259	0.281	2.693	7.683

Table 1. Constant rates for IP and PV variations at different temperatures

Results and Discussion

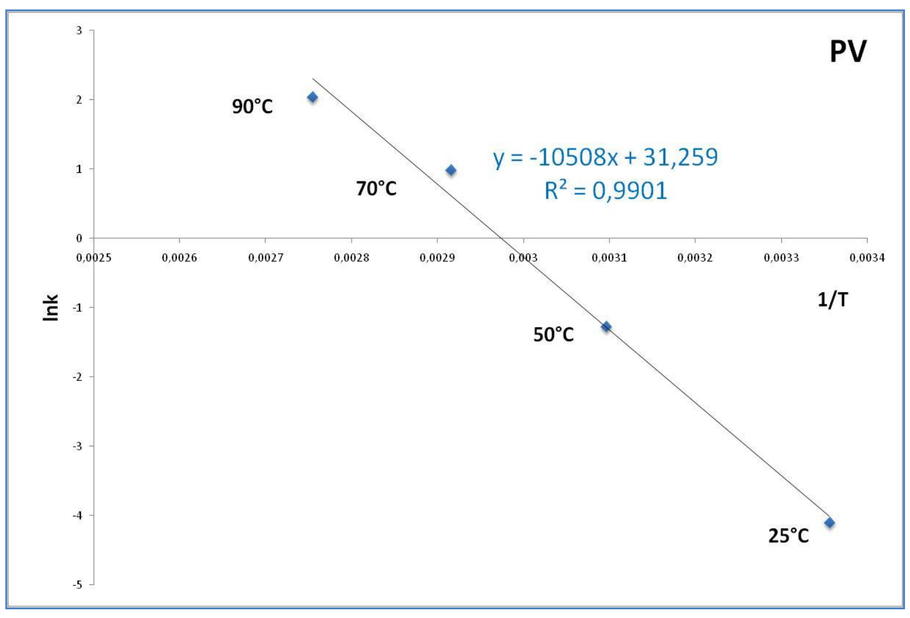


Figure 1. Change of the rate constant (k) at different temperatures (PV)

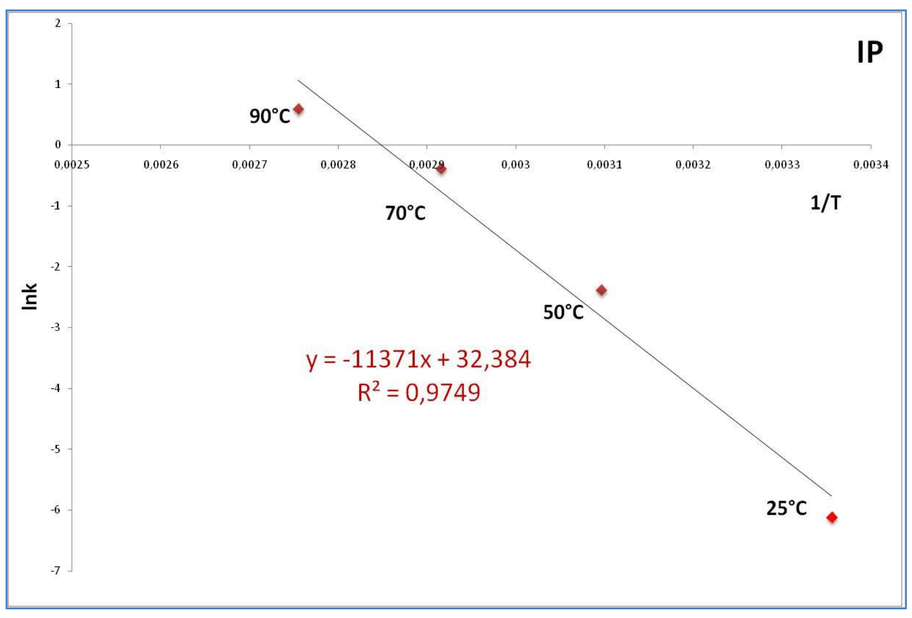


Figure 2. Change of the rate constant (k) at different temperatures (IP)

Figure 1 and 2 show the ability of both PV and Oxitest (IP) to measure the oxidative degree of soybean oil exposed at growing temperatures. The Arrhenius equation (***lnK = lnA - Ea/RT***) was used to determine the activation energy (Ea) of the oxidation reaction for each index. Also, a temperature acceleration factor, (*Q10)* based on the increase in oxidation rate from a 10°C increase in temperature, was calculated from the slopes of the lines (**Table 2**).

Index	R^2	Ea	Q_{10}
IP	0,9749	94 kJ mol^{-1}	3,1
PV	0,9901	88 kJ mol^{-1}	3,3

Table 2. Arrhenius parameters and Q10 for lipid oxidation described by the two indexes

The results summarized in **Table 2** show a similarity between IP and PV responses.

Figure 3 shows the good correlation that exists between the two methods at 70°C. Similar results were obtained also for the others storage temperatures (data not shown).

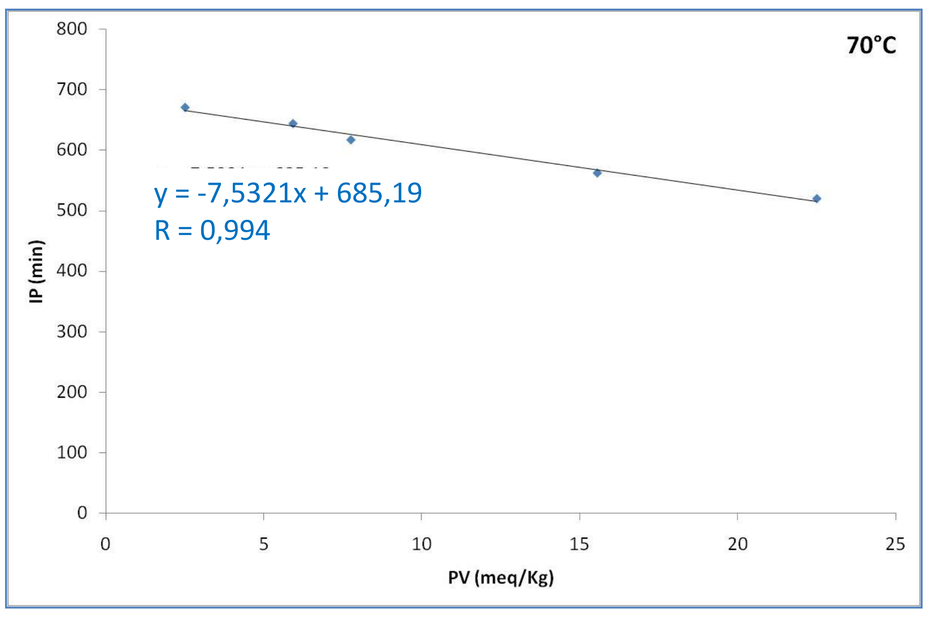


Figure 3. Correlation between IP and PV at 70°C

Conclusions

The results show that the Oxitest could be a helpful solution for monitoring the vegetable oil oxidation. It could be used alternatively to traditional and time-consuming methods with several advantages: analytical rapidity, easiness of use, reproducibility and reduced production of chemical wastes. Oxitest is also a promising instrument in order to study oil shelf-life in accelerated conditions. A good level of correlation with a traditional method like Peroxide Value was found (R > 0,98).

References

1) Farhoosh R, Niazmand R, Rezaei M, Sarabi M (2008). Kinetic parameter determination of vegetable oil oxidation under Rancimat test conditions. Eur J Lipid Sci Technol 110:587-592.
2) Hyung Y C. (1997). Reaction Mechanisms and Kinetics of Antioxidant Using Arrhenius Equation in Soybean Oil Oxidation, *J. Food Sci. Nutr. 2: 6-10.*
3) Mora L, Piergiovanni L, Limbo S, Maiocchi P. (2009). Valutazione della stabilità ossidativa di oli vegetali mediante reattore per test di ossidazione oxitest. Industrie Alimentari, 48 : 51-56.