Application of the Oxitest® method to evaluate the Oxidation stability of edible oils at different working temperatures under accelerated conditions

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INTRODUCTION

Lipid oxidation is one of the most serious problems occurring during storage of fatty foods, causing a shortage of their shelf-life. A number of accelerated methods have been developed to test the resistance of edible fats and oils to oxidation (Farhoosh et al., 2008). All these accelerated methods involve the use of elevated temperatures because the rate of the oxidative reaction is exponentially related to the temperature. Oxitest® reactor (Velp Scientifica, Usmate - Italy) has been successfully used to measure the resistance to oxidation of raw materials and finished food-feed without preliminary fat separation (Mora et al., 2009). Oxitest® is based on the absolute oxygen pressure change in a closed and thermostatic chamber, assumed as the oxygen uptake by reactive substances. The tests allow to obtain an oxidation curve, characterized by an Induction Period as the time required to reach an end point of oxidation corresponding to either a level of detectable rancidity or a sudden change in the rate of oxidation.

AIM

This work aimed at:

1. Discriminating the resistance to oxidation among 5 different edible oils;
2. Investigating the influence of temperature, the most relevant variable taking part in the autoxidation reactions.

MATERIALS AND METHODS

SAMPLE PREPARATION

Five different edible oils were used for the test. Before analysis, they present a similar POV value. Oxitest® working conditions are shown in **Table 1**. Each analysis was repeated four times using two different reactors. The Oxitest® response is the Induction Period (IP) expressed as a "stability time" before fat oxidation; it can be calculated by a graphical method **(Figure 3)**.

❑Maize oil (PET 1L) POV < 10 meqO_2/kg

❑Virgin olive oil (glass 1L) POV < 10 meqO_2/kg

❑Peanut oil (PET 1L) POV < 10 meqO_2/kg

❑Sunflower oil (PET 1L) POV < 10 meqO_2/kg

❑Mixed seed oil (PET 1L) POV < 10 meqO_2/kg

10g of oil was distributed in each sample holders of the reaction chambers (**Figures 1 and 2**)

Figure 1- Reaction chambers of Oxitest ® reactor

Figure 2- Oxitest ®

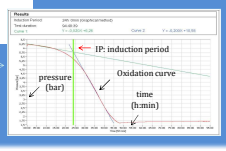

Figure 3-Typical oxidation curve

TEST CONDITIONS

	I test	II test	III test
Temperature (°C)	90	80	70
Pressure (bar)	6	6	6
Gas test	oxygen	oxygen	oxygen

Table 1- Oxitest ® working conditions

RESULTS AND DISCUSSION

Resistance to oxidation: discrimination among different edible oils

Oxidation curves of the five oils, analyzed in the same conditions (90°C, 6 bar of oxygen) are shown in **Figure 4**. Oxitest® has the ability to discriminate the resistance to oil oxidation. **Table 2** shows different Induction Periods which depend on the composition of the oil and its botanical origin. For example, oxidation of sunflower oil is faster (IP=10,9h) than virgin olive oil (IP=22,7h), characterized by a lower antioxidant content.

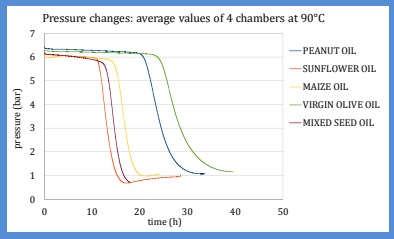

Figure 4 - Oxidation curves of edible oils with Oxitest ® at 90°C

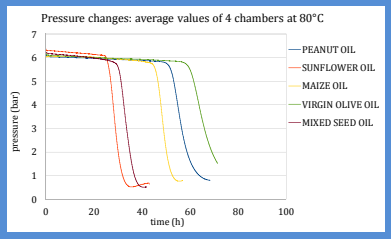

Figure 5 - Oxidation curves of edible oils with Oxitest ® at 80°C

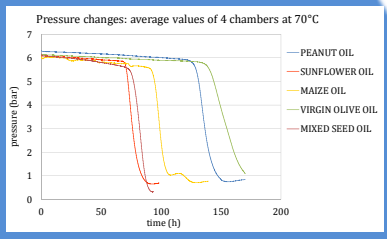

Figure 6 - Oxidation curves of edible oils with Oxitest ® at 70°C

Temperature effect on edible oils oxidation

Oxitest® reactor can be used at different temperatures and oxygen pressures. To evaluate the temperature effect on the Induction Period, the oils were analyzed at 90, 80, 70°C and 6 bar of oxygen pressure. The repeatability of **Oxitest®** reactor is estimated using the coefficient of variation of Induction Period. It rarely exceeds 5% in each analysis (**Figure 7**). Oxidation curves of oils are shown in **Figures 4, 5, 6**. They show that the trend of oil oxidation is the same for the three temperatures but the Induction Period increases with the decrease of the temperature (**Table 3**). In particular, the relationship between IP and temperature is exponential and it follows the Arrhenius law, as shown in **Figure 8**. Coefficients of determination are always higher than 0.99, emphasizing a good relationship between IP and the temperature.

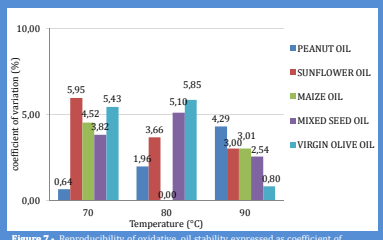

Figure 7 - Reproducibility of oxidative oil stability expressed as coefficient of variation for n=4

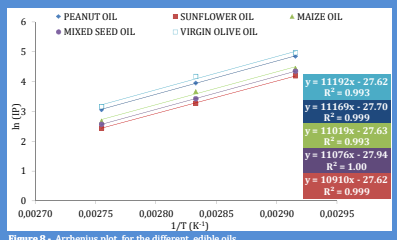

Figure 8 - Arrhenius plot for the different edible oils

	P	T	Average IP
Units	(bar)	(°C)	(h)
Sunflower oil	6	90	10,9
Mixed seed oil	6	90	12,6
Maize oil	6	90	14,8
Peanut oil	6	90	20,3
Virgin olive oil	6	90	22,7

Table 2 - Induction Period average values obtained with Oxitest®

	IP_{90}	IP_{80}	IP_{70}	RATIO
Units	(h)	(h)	(h)	IP90/IP70
Peanut oil	21.28	52.05	128.05	6,0
Sunflower oil	11.46	26.17	66.08	5,8
Maize oil	14.52	39.04	85.47	5,9
Mixed seed oil	13.08	30.78	77.46	5,9
Virgin olive oil	23.75	64.96	143.73	6,1

Table 3 - Influence of the temperature on IP

CONCLUSION

With Oxitest® reactor it is possible:

- to evaluate the oxidative status of different edible oils and finished food-feed products in short time;
- to calculate the Induction Period of different edible oils and to discriminate their resistance to oxidation;
- to perform accelerated shelf-life tests, estimating the IP value at storage temperature, evaluating the temperature effect.

REFERENCES

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