QCL FOOD SCIENCE

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Monitoring High Temperature Oil Oxidation by Oxygen Consumption

Vegetable oils employed for various purposes, such as deep frying and biodiesel production, undergo extensive oxidation and degradation during high-temperature (>100 °C) processes. Antioxidants can protect them from peroxidation with an efficacy that depends on various factors, including oil composition, chemical structure of the antioxidant, temperature, and presence of impurities. The tendency of oil to oxidize and the effectiveness of antioxidants can be determined with good accuracy by measuring O2 consumption in the head space by an oxygen sensor.

Oil oxidation is performed at 130 °C in a 10 mL round-bottom flask surmounted by a water-cooled refrigerator. To measure the oxygen consumption, the optical oxygen meter and the thermometer are introduced on the top of the refrigerator through a silicone septum ensuring sealing of the apparatus (see Fig. 1).

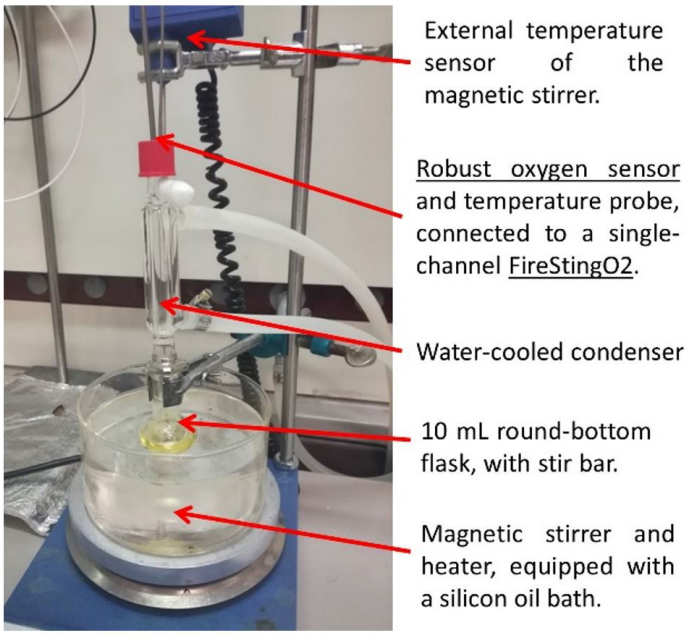

Fig 1: Apparatus for measuring O2 uptake during oil oxidation

The samples, consisting of 1 or 2 mL of oil, pure or dissolved in a suitable high-boiling solvent, are vigorously stirred by an olive-shaped stir bar and are heated to the required temperature (up to 180 °C) by a silicone oil bath. The glass condenser maintains the probe tip at about 30 °C. The amount of O2 consumed (in mmol) is calculated from the concentration of O2 in the headspace and the internal volume of the apparatus.

As the reaction tends to slow down at low O2 levels, if needed the vessel can be opened, fluxed with fresh air, and closed again to continue the data collection. In Fig. 2, the O2 uptake at 130 °C for two palm oils with different purification degree is reported. An induction period due to the presence of antioxidants can be noticed in the unrefined palm oil sample.

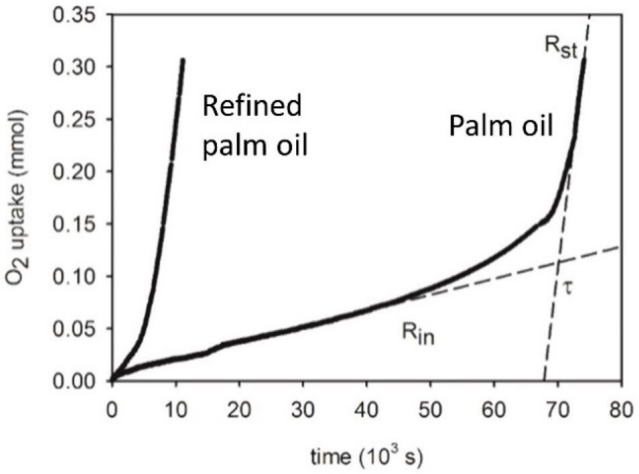

Fig. 2: Oxidation at 130 °C of two samples having different levels of antioxidants (see F. Mollica et al. Antioxidants, 2020, 9, 399 doi.org/10.3390/antiox9050399)

In conclusion, this method represents an easy and accessible way to measure the stability of oils at high temperature and to study the efficacy of antioxidants. All that is needed is an O2 probe and glassware normally present in an organic chemistry laboratory.

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