The effect of storage conditions and storage containers on olive oil quality

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The effect of exposure to different temperatures, light and oxygen on the quality of olive oil was investigated in RIRDC publication no. 12/024 (Ayton et al, 2012). The project was carried out over a 36-month period, with the oils tested after 3, 6, 12, 18, 24 and 36 months of storage. Storage conditions were at different temperatures, light exposure and oxygen exposure (Table 1). The effect of storage in different types of containers on the quality of olive oil were investigated in RIRDC publication no. 09/160 (Mailer and Graham, 2009) and publication no. 12/008 (Mailer et al, 2012). The projects investigated the effect of different types of storage containers, including polyethylene, nylon, metallised polyester, silver foil, HDPE as well as multi layered products containing more than one type of material, on the quality of olive oil during storage.

Storage conditions

The report (RIRDC publication no. 12/024) showed that different storage conditions had a significant effect on the quality and shelf life of olive oil. It showed that analytical methods cannot be used in isolation to determine the status of an oil. It also showed that each storage condition imposed in the study exhibited distinct patterns which were useful indicators for determining the potential shelf life of the products.

Storage temperature

Peroxide value (PV), UV absorbance at 268nm (K_{268}) and free fatty acids (FFA) increased in all oils, however the samples exposed to higher temperatures increased at a greater rate than those stored at the lower temperatures.

Pyropheophytin a was significantly affected by storage temperature, with the oils stored at 37°C exceeding the Australian standard limit for *pyropheophytin a* (<17%) almost immediately. Storage at lower temperatures showed a constant, linear increase over time in *pyropheophytin a,* which was very similar in all oils regardless of the initial matrix, making it a useful indicator of aging of oils.

1,2-diacylglycerols were also useful indicators of determining the age of oils as they too showed a predictable pattern of decrease at lower temperature. However, initial free fatty acid content has an influence on the rate of decline, with initial high FFA content increasing the rate of decline. Higher storage temperatures caused 1,2-diacylglycerol content to decrease rapidly, with oils almost immediately falling outside the Australian standard (>35%).

Induction time was shown to increase in oils exposed to higher temperatures. This is a significant result of this study as high induction times do not necessarily indicate high quality oil. Sensory profile was significantly affected by storage temperature, with high temperatures leading to degradation of positive attributes over time, while negative attributes such as rancidity developed quickly and to significant levels.

Exposure to oxygen

Peroxide value, K_{232}, K_{268}, *pyropheophytin a*, polyphenols, α-tocopherol, chlorophyll, fatty acid composition, induction time and sensory attributes were all significantly affected when oils were exposed to oxygen. PV and UV absorbance changed in predictable patterns and were significantly affected almost immediately. Sensory properties were quickly and significantly affected with exposure to oxygen, showing that this analysis is also a good indicator of poor storage.

Exposure to light

The most significant effect of exposure to light was the almost complete degradation of *pyropheophytin a*, as well as a significant decrease in tocopherols. Sensory properties were also affected, with exposure to light increasing negative attributes.

Storage containers projects

Results from the initial project to investigate the effect of different type of storage containers on olive oil quality (RIRDC publication no. 09/160) was confounded by issues such as inappropriate storage temperatures and large headspace in the containers being investigated. Publication no. 12/008 investigated storage containers in more controlled conditions, especially constant temperature at 22°C.

Storage of olive oil in nylon, metallised polyester, silver foil and HDPE generally did not affect oxidative degradation indices over time. Storage in polyethylene led to increased oxidation indices such as PV and UV absorbance.

Pyropheophytin a and diacylglycerol degradation patterns were similar to those observed in the storage conditions project.

Recent developments

A disadvantage of trying to estimate the effect of storage conditions on olive oil is the requirement of completing the analysis over an extended period. Accelerated oxidative stability tests such as increasing temperature (100-130°) as well as increasing exposure to oxygen can be used. However, artefacts not normally present in oils stored at ambient temperatures such as polymerisation and formation of aromatics can occur. Some researchers have attempted to develop mathematical equations to predict the effect of storage condition on oil quality. However, it is generally confounded by interactions between the initial quality of the oil and the formation of degradation products. Sanmartin et al (2018), compared the effect of storage containers and storage temperatures on the quality of olive oil and reported similar conclusions to the RIRDC reports.

Packaging materials for the storage of olive oil have not changed significantly since this report was published. Most of the olive oil for retail sale is sold in dark glass bottles. Bulk storage for small/medium producers tends to be in large HDPE pallecons or smaller 20 Litre drums. Anecdotally, there has been a small but significant increase in the amount of oil sold in small collapsible “cask” like containers.

Future research

Rather than measuring parameters such as oxidation by-products or degradation of antioxidants, indicators or markers can be used to determine oil quality. With technological advances in analytical instruments leading to smaller, less expensive instruments, they are becoming more commonplace in laboratories. As a result, new analytical tools are becoming available to test olive oil quality. For example, Infrared and Raman spectroscopy can be used to determine oxidative degradation paramaters such as peroxide value and UV absorbance quickly and inexpensively. In recent times, gas chromatography-mass spectrometry (GC-MS), nuclear magnetic resonance (NMR) and electron paramagnetic resonance (EPR) have increasingly been used to detect marker bands in spectra or multiple compounds and isomers to detect oxidation or aging in oils. These instruments can produce copious amounts of data and when they are used in conjunction with chemometric data analysis, complex interaction and reactions can be determined at different stages of the oxidation process.

Table 1 Summary storage conditions project 12/024

Temperature	15°C	closed	dark
	22°C	closed	dark
	37°C	closed	dark
Oxygen	22°C	open	dark
	22°C	closed	dark
Light	22°C	closed	light
	22°C	closed	dark

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