Best before …

Determining the oxidation stability of fats and oils using the Rancimat method

Foodstuffs that contain fat – like butter, nuts, cookies, and potato chips – turn rancid over time. This is caused by chemical changes in the fat; in particular, its oxidation. Because of this, determining the oxidation stability of fats and oils in foods has proven to be a useful tool in the quality control of foodstuffs. And the Rancimat method is designed to perform this exact task.

Double bonds: Twice as much isn't always twice as good

Fats are glycerin triesters with three fatty acid residues (Figure 1). The extent to which fatty acid residues react with substances in their environment depends on their chemical structure; where fats in foodstuffs are concerned, this mainly involves atmospheric oxygen. The double bonds in monounsaturated or polyunsaturated fatty acids are particularly reactive; as such, fats and oils containing unsaturated fatty acid residues demonstrate lower oxidation stability than those containing only saturated fatty acid residues.

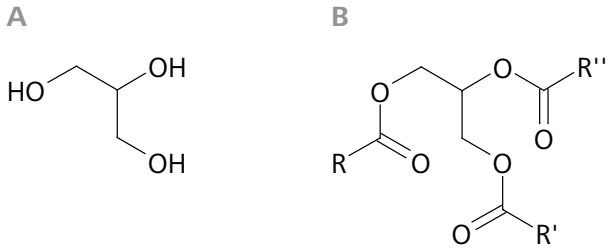


Figure 1. A Glycerin; **B** general structure of a fat molecule; R, R', and R" represent aliphatic, generally unbranched hydrocarbon residues

As well as the structure of fats and oils (oils being fats that are liquid at room temperature), the ambient conditions also have an effect on shelf life, as higher ambient temperatures and increased oxygen exposure accelerate the oxidation process.

Time flies

The Rancimat method turns this dependency on conditions into an advantage, exposing the sample to a higher temperature while passing a continuous stream of air through it. A process that might normally take weeks, months, or even years is completed within a matter of hours in the Rancimat: Peroxides are produced during the first stage (Figure 2). These are unstable; over time, the fatty acids are broken down completely and secondary oxidation products are formed, including volatile low-molecular organic acids such as acetic acid and formic acid.

The air flow transports the volatile oxidation products into a second vessel, which contains distilled water. This water's conductivity is continuously measured, with increases being registered when volatile acids appear in it. The time that elapses until the point when volatile acids are detected in the measuring vessel is referred to as the induction time or oil stability index. This is a measure of oxidation stability: the longer the induction time, the more stable the sample. Figure 3 (next page) shows the process of determining oxidation stability in potato chips.

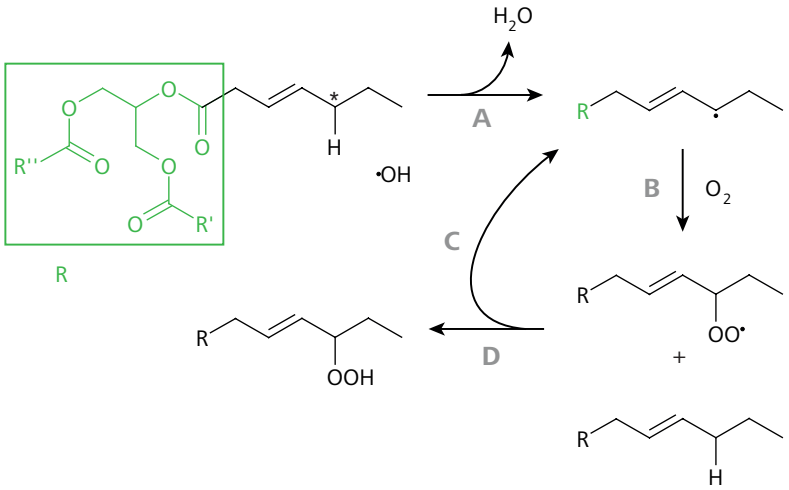


Figure 2. Diagram showing peroxidation of a monounsaturated fatty acid. **A** Due to its position next to the double bond, the methylene group marked with the asterisk is particularly susceptible to H atom removal. This is where the hydroxyl radical attacks. **B** The reactive radical binds molecular oxygen from the ambient air. **C + D** From a reaction with a «fresh» fatty acid, a peroxide and a free radical are arise – a chain reaction begins.

Normally, fat analysis can only yield information about a sample's current state. For example, determining the acid value indicates the quantity of KOH that is required to neutralize the free organic acids in a gram of fat – at the time of the measurement. The acid value is thus a measure of the free organic acids that are present in the sample at that time. By contrast, the Rancimat method acts as a crystal ball for fat behavior: thanks to the accelerated aging that takes place in the sample when it is exposed to higher temperatures and air in the Rancimat, this method is able to predict the way in which the fatty acids will break down in the future – and how quickly.

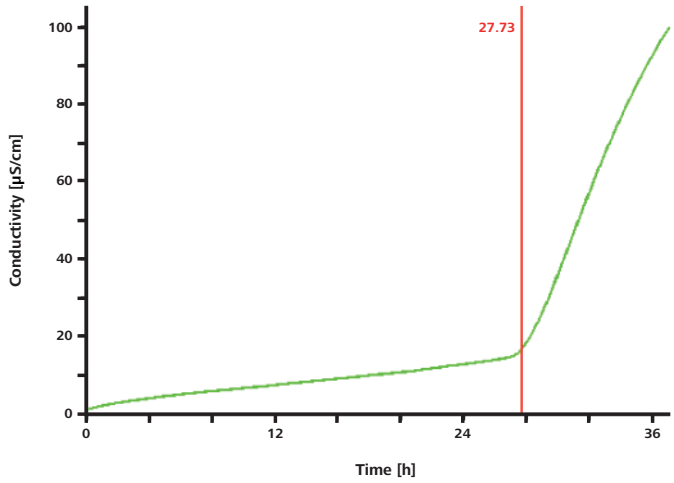
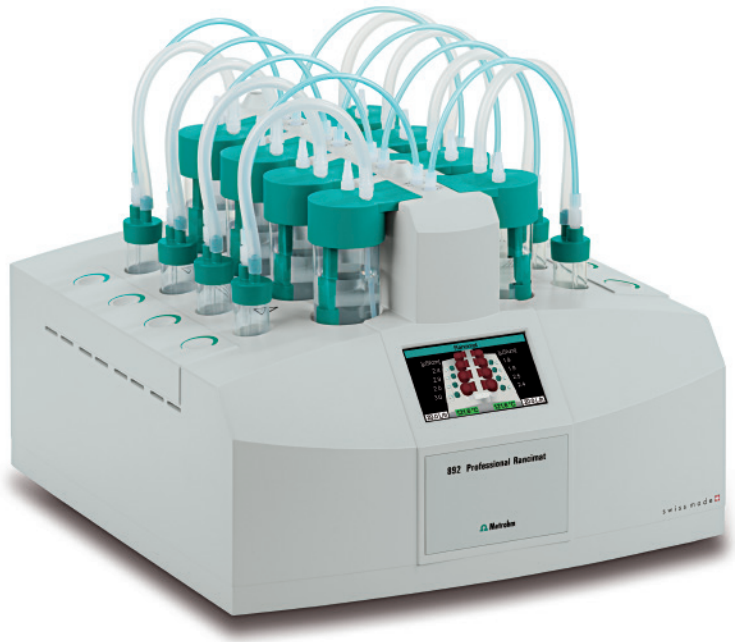


Figure 3. Direct measurement (without prior extraction) of the oxidation stability of potato chips at 120 °C. Following the induction time of 27.73 hours, the water conductivity starts to rise suddenly.

Any kind of sample, with hardly any effort

With the Rancimat, it is possible to determine the oxidation stability of both liquid and solid samples. Solid samples must be comminuted first so that oxygen can get to every part of the sample material; ideally, it should be pulverized before measurement. Samples with a consistent particle size distribution yield the best results: as this gives oxygen access to the entire sample, volatile acids are produced within a short space of time, resulting in a steep curve that can be evaluated with particular accuracy.

Normally, comminuting of the sample is the only preparation step that it has to undergo. Only when dealing with samples with a low fat content or processed foods (such as powdered milk), the fat has to be extracted before measurement.



The Rancimat method provides reliable information about the oxidation stability of fats and oils as well as fatty foods. It can also be used to analyze cosmetics. The established method is outlined in various national and international standards (see Table 1).

For more examples and detailed information about analysis conditions, download application AB-408 from our website. Find out more about the Rancimat method here: **bit.ly/Rancimat**

Table 1. The Rancimat method in international standards

AOCS Cd 12b-92*	Sampling and analysis of commercial fats and oils: Oil Stability Index
ISO 6886	Animal and vegetable fats and oils – Determination of oxidative stability (accelerated oxidation test)
2.4.28.2-93	Fat stability test on Autoxidation. CDM, Japan

*AOCS – American Oil Chemists' Society

A process that might normally take weeks, months, or even years is completed within a matter of hours in the Rancimat.

The 892 Professional Rancimat determines the oxidation stability of fats and oils such as those found in foods.