Shelf Life Prediction With a Combination of "Rancimat" and NIR Spectroscopy

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Rancid oil or food, such as olive oil, nuts, chocolate, butter, can ruin your joy of meals or snacks. Even cosmetic products can be affected by bad odour if rancid or old oils or fats are used in production. The double bounds in most healthy oils make them even more sensitive to oxygen. Oxygen creates peroxides, aldehydes, ketones and carbonylic acids and unfortunately even small quantities of that have a negative impact on the taste. Light exposure and high temperatures accelerate this process. However, this process still is slow: typically, it rather takes weeks or months than hours.

The challenge for shelf-life estimation in quality control of food producers is the determination of the storage history of incoming raw materials. How long and how well has the oil been stored, how much was it exposed to high temperatures, oxygen or light during storage. What expiry date can be predicted for the final product? Repeatedly bad experience with rancid products can destroy consumer trust and ruin a brand reputation.

An analytical method for this problem is the "Rancimat". It offers the determination of the oxidative stability. The instrument simulates accelerated storage by speeding up the sample's oxidation process. This is achieved by keeping the sample at an elevated temperature while passing a continuous stream of air through it, transporting volatile oxidation products into a vessel containing distilled water and a measuring cell. The "Rancimat" observes the conductivity of the water until a jump in conductivity marks the "induction time", which gives the sample's resistance to oxidation. The induction time is a standard parameter in quality testing of oils and fats in the food industry and gives indications about the quality of the oil and allows an estimation of the remaining shelf life.

A common alternative for this estimate is the determination of the PV (Peroxide Value) with titration.

There is even a much quicker and easier way to determine those parameters with NIR-Spectroscopy. However, NIR is a secondary method and needs to be trained by a primary reference method. The combination of Rancimat and NIR-Spectroscopy is ideal to create a model as there is a good correlation between the data of both methods.

NIR spectroscopy only takes seconds, does not need sample preparation, needs no chemicals, such as solvents, titrants or eluents and thus is almost free of waste. As it is not destructive, the samples can be stored as a backup.

With the new OMNIS Sample Robot NIR, the aging of oils can even be correlated through long term investigation: prepare a sample reck with vials for storage. In defined intervals (days, weeks or months) the rack can be automatically processed and create a time dependent curve. Leave the sample vials closed. After 6 month you might see changes in the PV to determine the real end of shelf life. This can be used for a confirmation of the correct aging simulation. This technique can be used to perform a lot more shelf-life stability investigations of other products.

[1] Metrohm application research, internal measurements for a customer project from 2023.
[2] https://www.metrohm.com/de_ch/applications/whitepaper/wp-059.html Herisau, 2020.