CDRFoodLab®

CDR Paper 2306

QUALITY CONTROL OF FRYING OILS IN THE SNACK INDUSTRY

The continuous monitoring of frying oils is fundamental to obtain high quality snack products. The traditional analytical techniques used in the quality control of cooking oils are lab-intensive and require trained staff. CDR FOODLAB® enables one to control the quality of frying oils during the manufacturing stage with a fast, simple, and reliable method. FILSORB extends the shelf-life of both oils and final products.

Degradation processes in frying oils

Fats consists of **glycerol molecules**, in which three fatty acid chains are connected via **ester bonds.** The frying process degrades the fat, breaking the **fatty acid's ester bonds**. As a consequence, the so called **Free Fatty Acids (FFAs) are released in the frying solution.** The FFAs promotes the binding processes with hydroxyl groups, which are formed in cooking oils due to the ionization of water and other soluble compounds (i.e. proteins). Those processes cause the production of **peroxides**, which are considered the **primary oxidation markers** of cooking oils. Peroxides can quickly decompose with the formation of **aldehydes** and **ketones, otherwise measured as the anisidine value**. The breakdown of peroxides can be monitored in frying oils by evaluating the **anisidine** content.

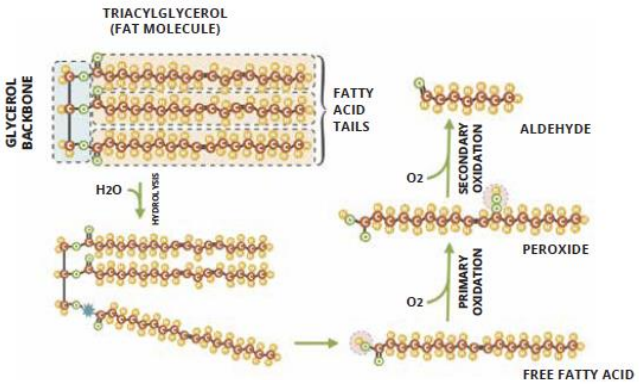

Figure 1. Degradation mechanisms of fat molecules into FFAs, peroxides and aldehydes.

The peroxide content of most cooking oil samples will firstly increase, then decrease due to the decomposition of peroxides into aldehydes and ketones. On the contrary, the anisidine concentration will progressively increase over time [1].

Figure 2. Comparison between fried products cooked in high FFAs oil (sx) and low FFAs oil (dx).

Quality control in snack industries

The **main goal** of industrial frying is to **preserve the integrity of cooking oils** as much as possible. This is aimed to **extend the shelf life** of cooking oils along with the fried/roasted products. Cooking oil is degraded with the release of FFAs, **which tend to be absorbed into the food.** This brings about two negative effects:

1. Fried products generally present **abnormal colors**, with **poor taste** and **high oil absorption**;

2. The FFAs absorbed into the food will oxidize into **peroxides, causing further rancidity**.

In theory, the **formation of peroxides can be limited** in two different ways:

1. By **reducing** the amount of **water and amino acids** released in the frying oil;

2. By **decreasing** the **concentration of FFAs**.

The first option is practically impossible, since the frying process requires the immersion of food into

cooking oils, with the consequent release of both water and amino acids. Therefore, **a decrease in FFA concentration is the only possible way to limit peroxide and anisidine formation**, which contribute to the rancid sensory characteristics of the final fried products.

For those reasons, it is **essential** to perform quality control of cooking oils by **evaluating the FFA, peroxide, and anisidine contents**. Generally, the FFA content must be kept under a certain threshold value. If the FFA level exceeds the approved range, **the cooking oil must be disposed of or treated.** However, the estimation of **FFAs alone is insufficient**. Only **the combined analysis of FFAs, peroxides and anisidine** provides a **realistic and reliable overview** of the quality of frying oils.

Traditional methods to perform quality control on frying oils

The quality control of frying oils is performed by standard procedures, which are the ***Official Methods and Recommended Practices* of the American Oil Chemists' Society (AOCS).** FFAs and peroxides are measured by means of **titrations**. In particular, the evaluation of FFAs is performed by the **AOCS Official Method Ca 5a-40**, which consists in an acid-base titration **[2]**. The concentration of peroxides is determined by iodometric titrations, according to the **AOCS Official Method Cd 8-53 [3]**. This procedure presents the disadvantage of being highly empirical, its results and accuracy strongly depend on the experimental analytic conditions. For example, the peroxide evaluation by the AOCS Official Method Cd 8-53 can be affected by the iodine absorption at the unsaturated bonds of the fatty material. Also, the presence of oxygen in the solution being titrated determines the liberation of iodine from potassium iodide, consequently causing the so-called *oxygen error*. All of these factors negatively affect the peroxide analysis, leading to **potentially overestimated peroxide values [3]**. Anisidine in frying oils is measured by the **AOCS Official Method Cd 18-90 [4]**. It is a **spectrophotometric technique**, which can be **quite expensive** and consists in reading absorbance values at 350 nm as the result of reactions between aldehydic compounds and p-anisidine in acetic acid solutions. Furthermore, all the previously described **AOCS analysis are lab-intensive**, requiring the use of **bulk reagents, glassware, fume hoods, and trained staff**. Therefore, those methods cannot be used directly along the production line and are generally performed by external laboratories. **The impossibility to perform real-time quality control is a significant disadvantage** in the use of traditional AOCS methods causing industrial producers the inability to quickly plan corrective actions and solve potential production problems.

Another parameter used to evaluate the quality of cooking oils is **Total Polar Compound (TPC)** value**.** The TPC measurement detects the **total amount of frying degradation products** (**FFAs, aldehydes, ketones, alcohols, non-volatile products**), which are characterized by higher polarity values if compared with triglycerides. The TPC evaluation can be performed by the **AOCS Official Method Cd 20-91 [5]** and the international standard **ISO 8420:2002** (https://www.iso.org/standard/33289.html), which consist in chromatographic techniques and must be performed by specialized laboratories and trained staff. Although the TPC content is mentioned by many different regulations [6], **this parameter is not useful in providing the whole picture** about the quality of cooking oils. Indeed, the TPC content is a **cumulative reading** of FFAs, peroxides and anisidine values, whereas **it is necessary to perform a separate quantification** of those compounds **to distinguish between initial and advanced**

degradation states (primary and secondary oxidation, respectively).

Preserving the quality of frying oils with FILSORB

The release of FFAs in cooking oils affects the quality of fried food and causes a reduction in their shelf life. Indeed, the **absorption of FFAs by food causes discoloured products with poor taste and an enhanced tendency to** 20 **become rancid.** If FFA values are higher than a certain range, companies will need to replace the cooking oil with virgin oil. However, the price of new virgin oil is extremely expensive. **An alternative solution is the use of the innovative oil adsorbent FILSORB,** which consists of a mixture of powdered silicates/silicas specifically designed to decrease the concentration of FFAs on a large scale. **FILSORB can remove up to 70-80% of all the FFAs present in cooking oils.** This enables the reduction of oxidation markers on both oil and final products, thus **extending their shelf-life**. **FILSORB** is compatible with any type of pressure or vacuum filtration system working with paper or fabric membranes. Figure 3 shows the application of **FILSORB XP 20** reducing the amount of FFAs in a mixture of cottonseed and peanut oil. After treatment with Filsorb XP 20, the total amount of oleic acid in the sample **decreases from 0.3%**

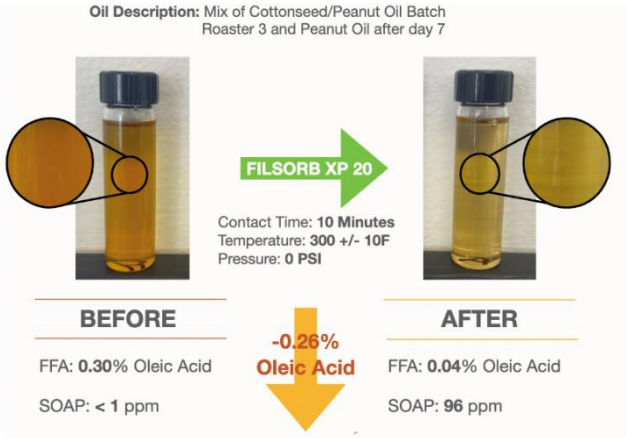

Figure 3. Application of FILSORB XP 20 on a mixture of cottonseed and peanut oil sample.

Easy and fast analysis of cooking oils with CDR FoodLab®

The traditional AOCS methods for the analysis of cooking oils are lab intensive and must be performed by trained staff. Consequently, those techniques do not allow real-time monitoring over an industrial frying process. A solution to this problem is **CDR FoodLab® Analysis System**, which is used worldwide to run analysis on fats and oils, **directly along the production line.**

CDR FoodLab® is equipped with an **innovative photometric analyser based on LED technology**, with reading and incubation cells thermostated at 37 °C. By using the CDR FoodLab®, it is possible to perform **easy analysis** thanks to **pre-vialed and ready to use reagents, with no need of glassware or specialized staff**. The quality control of oils in terms of their FFAs, , and anisidine contents can be performed very fast by using very **low volumes of sample, with results ready in less than 5 minutes**. Furthermore, CDR FoodLab® is supplied **pre-calibrated**, with the significant advantage of **not requiring further calibration or maintenance over time**. CDR FoodLab® can also be **equipped with a printer or PC connection.**

Bibliography

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[2] I.H. Rukunudin, P.J. White, C.J. Bern, T.B. Bailey, A Modified Method for Determining Free Fatty Acids from Small Soybean Oil Sample Sizes, *JAOCS* **1998** *75* (5), 563-568. doi:10.1007/s11746-998-0066-z.

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