QCL DAIRY SCIENCE

CDR FoodLab
Butter and Margarine
Quality Control for Long Production Cycles

Introduction
Butter and margarine are widely consumed fat based products that must maintain consistent texture, flavour, and oxidative stability throughout extended production and storage periods. While butter is derived from milk fat and margarine from vegetable oils, both products are expected to deliver similar sensory characteristics.

However, long production cycles and storage conditions expose these products to chemical degradation, particularly lipid oxidation and hydrolytic rancidity. These phenomena can significantly compromise product quality, leading to off-flavours, reduced shelf life, and non-compliance with quality standards.

For producers and quality control laboratories, the key challenge is to monitor critical parameters rapidly and accurately, ensuring product consistency and stability over time.

Chemical Composition and Structural Aspects
Butter is a relatively simple product in terms of formulation, typically composed of 80 to 82% milk fat, 16 to 17.5% water, and minor components such as salts and milk solids. Margarine, on the other hand, is a complex emulsion consisting of vegetable oils, water, emulsifiers, and additives.

Despite their differences, both products share a common feature: their quality is strongly influenced by the behavior of lipids.

Lipid Structure and Stability
In butter, lipids are primarily present as triglycerides, organized within milk fat globules. These structures play a crucial role in determining melting behavior, spreadability and texture.

In margarine, lipid functionality is engineered through processes such as hydrogenation or interesterification, which modify the ratio of saturated and unsaturated fatty acids. This directly affects the physical properties such as consistency and plasticity and enhances the susceptibility to oxidation. Intrinsically these processes influence shelf-life stability, requiring producers to structure a proper quality control. The balance between saturated and unsaturated fats is critical.

Unsaturated fatty acids, while beneficial from a nutritional standpoint, are more prone to oxidation, leading to the formation of undesirable compounds.

Monitoring Lipid Degradation: Key Quality Parameters
During production and storage, fats can undergo two main degradation pathways:

1. Lipid Oxidation
This process involves the reaction of lipids with oxygen, leading to the formation of primary and secondary oxidation products. It results in rancid, cardboard-like off-flavours. Key parameters include:

- **Peroxide Value (PV)**, indicator of primary oxidation
- **Anisidine Value (AV)**, indicator of secondary oxidation products

2. Hydrolytic Rancidity
This reaction is caused by lipase activity, which breaks down triglycerides into free fatty acids. Key parameter:

- **Free Fatty Acids (FFA)** or Acidity

Monitoring these parameters is essential to ensure product stability, especially in long production cycles where storage conditions may accelerate degradation.

Traditional Methods vs Rapid Photometric Analysis
Conventional methods for analyzing lipid oxidation and acidity are typically based on titration techniques. While these methods are standardized and reliable, they present several limitations, including time-consuming procedures, the use of hazardous chemicals, the need for skilled personnel, and limited suitability for in-line or routine process control.

Rapid photometric analysis systems, such as the **CDR FoodLab**, offer an alternative approach by enabling fast and reliable measurements of key parameters directly in production environments or quality control laboratories. These systems require minimal sample preparation, use pre-filled reagents to ensure standardized analysis, eliminate the need for toxic solvents, and provide results in just a few minutes. This approach allows operators to perform frequent testing, improving process control and significantly reducing the risk of quality deviations.

Sample Treatment: Butter and Margarine Analysis
The extraction of the lipid fraction is a critical step to

eliminate water and impurities. Following these simple steps the fat is ready to be analyzed with the CDR FoodLab:

1. Melting: Weigh approximately 5 g of the sample into a centrifuge tube and melt it using a water bath
2. Dehydration: Add approximately 1 g of anhydrous sodium sulfate (Na2SO4) to the melted sample
3. Mixing: Close the tube and mix thoroughly to allow the drying agent to interact with the sample
4. Centrifugation: Centrifuge the tube for 5 minutes at 5000 rpm
5. Collection: Collect the separated oil phase (the clear upper layer) and use it for the analysis

Benefits for Quality Control in Long Production Cycles

Implementing rapid analytical methods combined with standardized sample preparation provides significant advantages for producers of butter and margarine. It enables continuous monitoring of oxidative stability and supports the early detection of degradation phenomena, allowing timely interventions before defects become critical.

At the same time, it contributes to improved consistency of texture and flavor, which are key quality attributes for these products. The availability of reliable analytical data also facilitates the optimization of raw material selection and processing conditions, leading to more controlled and efficient production.

Furthermore, it helps reduce product waste and rework by minimizing out-of-spec batches. In long production cycles, where products may be stored for extended periods before distribution, these benefits are particularly relevant, as real-time data allows corrective actions that preserve product quality and extend shelf life.

Conclusion

Butter and margarine production involves complex chemical and physical processes, where lipid stability plays a central role in defining product quality. Monitoring key parameters such as **Peroxide Value**, **Anisidine Value**, and **Free Fatty Acids** is essential to control oxidation and hydrolytic degradation.

The combination of rapid photometric analysis and standardized sample treatment allows producers to implement efficient, reliable quality control strategies, even in demanding production environments.

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