MultiScan MS 20

Stability Analysis of Milk substitute Products

dataphysics
Understanding Interfaces

Milk substitute products are attracting increasing interest due to their advantageous features regarding health, sustainability, and ethical concerns. To provide these products with desirable taste and nutritional value, various ingredients are present in many plant-based milk substitutes. However, milk substitutes are generally produced by mechanically breaking down plant materials, like nuts, legumes, seeds, etc., and mixing these with oil, water, and colloidal matter to form an oil-in-water emulsion. The stability of these complex mixtures is an essential parameter of the quality of each milk substitute since it significantly influences the taste and mouthfeel. It is important to optimise the composition to achieve a product that performs optimally during its entire lifespan from production to consumption. The stability study of five milk substitute formulations measured with the MultiScan 20 (MS 20) will be presented throughout this application note.

Fig. 1: Milk substitute samples.

Keywords: MultiScan 20 (MS 20) ▪ Stability Analysis ▪ Milk Substitute ▪ Creaming ▪ Sedimentation

Technique and Method

The MultiScan MS 20 (Fig. 2) from DataPhysics Instruments is the measuring device for an automatic optical stability and aging analysis of liquid dispersions and the comprehensive characterisation of time- and temperature-dependent destabilisation mechanisms. It consists of a base unit and up to six connected ScanTowers with temperature-controlled sample chambers. The ScanTowers of the MS 20 can be individually controlled and operated **at different temperatures (4 °C to 80 °C)**.

With its matching software MSC, the MS 20 is an ideal partner for the stability analysis since **even the slightest changes** within dispersions can be detected and evaluated. The MS 20 enables a fast and objective analysis of the dispersion stability as well as conclusions on possible **destabilisation mechanisms**.

Fig. 2: DataPhysics Instruments stability analysis system MultiScan MS 20 with six independent ScanTower.

Experiment

20 ml of each milk substitute formulation (five drinks based on peas, oats, coconut, almond or soy) were homogenised using a shaker and poured in a transparent glass vial to be measured at T = 25 °C every 6 min for 1 day and 3 hours. The measured zone was between 0 mm (bottom of the glass) and 57 mm (fill level of the vial). Fig. 1 shows the sample vials at the end of the measurement.

Results

As the samples were opaque the transmission signal was too weak and contained very little information throughout the measurement. Therefore, the backscattering signal was analysed to study the stability of all five milk substitutes.

Fig. 3 shows the backscattering intensities against the position for the five samples. The colour-coding of the curves indicates the time at which they were recorded, from red (start of the experiment, t = 0 s) to purple (end of experiment, t = 1 d 3 h). Every curve represents one individual measurement.

Table 1: Phenomena and possible destabilisation mechanisms in three different zones for five milk substitutes.

Sample	Bottom layer	Middle layer	Top layer
Peas	-	-	Creaming
Oats	Clarification	-	Creaming
Coconut	Sedimentation	Clarification	Creaming
Almond	Sedimentation	Clarification	Creaming
Soy	Sedimentation	-	Creaming

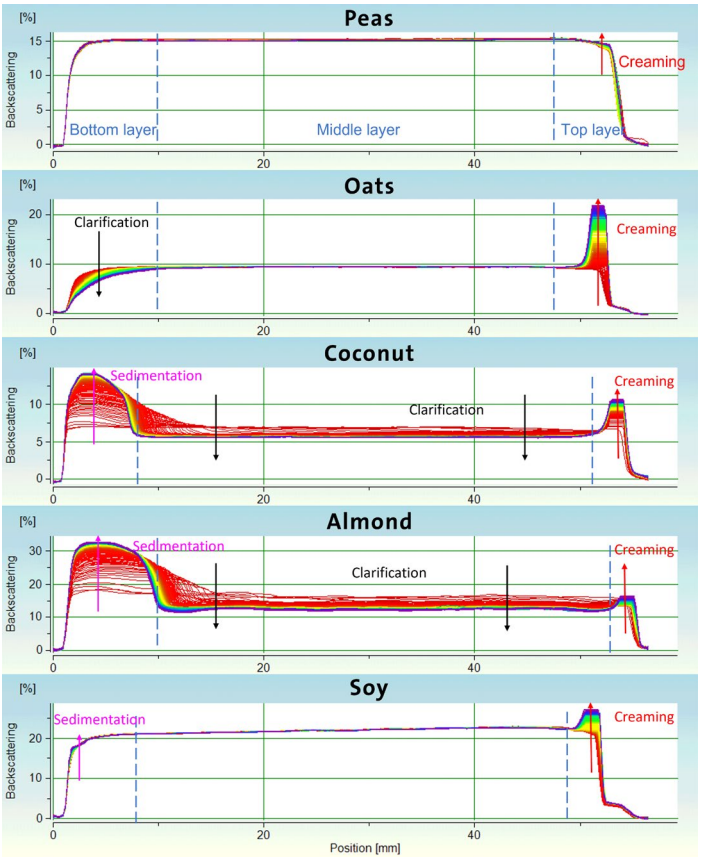

Fig. 3: Backscattering intensity vs. position for five different milk substitute samples.

The backscattering diagrams show a clearly time-dependent as well as position-dependent change of the signal that is induced by particle size changes or particle migration. The different destabilisation mechanisms are summarised in table 1.

1. Creaming

Fig. 4 shows how the thickness of the cream layer changes on the top of the samples. The creaming process in the oats, coconut, and almond drinks started instantly and was completed after around 2.5 h. In contrast, the cream layer in the soy and peas drinks forms much later.

The cream layer in the oats drink was the thickest with around 3.6 mm, whereas the one in the peas drink was the thinnest with around 1.5 mm. Notably, clarification was detected in the bottom layer of the oats drink, indicating a typical creaming process.

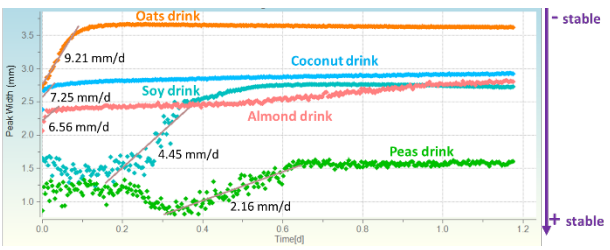

Fig. 4: Thickness of the creaming layer in all samples vs. time.

2. Sedimentation

The particles in the coconut, almond, and soy drinks precipitated in the bottom layer. The sedimentation kinetics for these drinks is shown in Fig. 5. The peak area change rate of the almond drink is highest with a value of 418.8 mm%/d, whereas the change rate of the peas drink is lowest with a value of only 1.72 mm%/d.

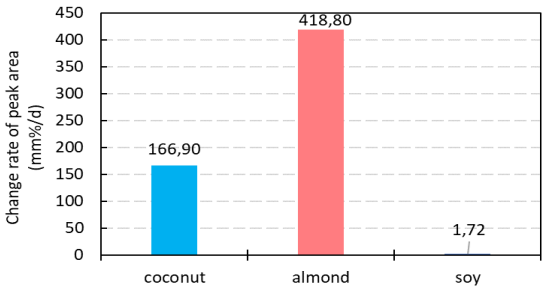

Fig. 5: Sedimentation kinetics vs. time for coconut, almond, and soy drinks.

3. Global stability evaluation

The MSC software can also provide a **global analysis** of the stability using the **stability index (SI)** function. This function summarises and quantifies the effects of various destabilisation mechanisms over the entire sample height. With these SI values we can compare the stability of different products (Fig. 6). In consistency with the changes in backscattering intensity the peas drink was found to be the most stable formulation, while the stability of the almond drink was lowest. The results underline the excellent applicability of the MS 20 to analyse and quantify stability issues of different formulations **locally** and **globally** with **high reliability**.

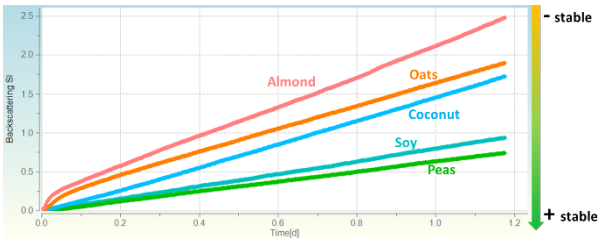

Fig. 6: Backscattering stability index of all samples vs. time.

Summary

Using the MS 20 stability analysis system and its corresponding MSC software, an **easy and fast way** to study the stability of milk substitute formulations could be demonstrated. **Changes can be detected readily and reliably** which enables the producer to anticipate and quantify **stability issues** and thus **guarantee time and cost** optimal product development.

DataPhysics Instruments GmbH • Raiffeisenstraße 34 • 70794 Filderstadt, Germany
phone +49 (0)711 770556-0 • fax +49 (0)711 770556-99
sales@dataphysics-instruments.com • www.dataphysics-instruments.com