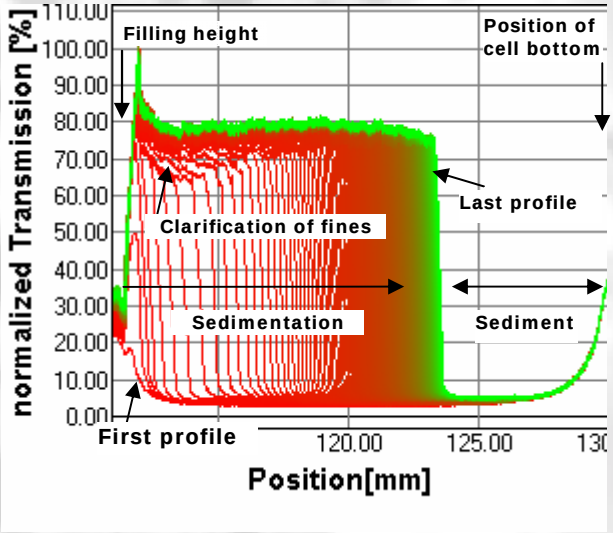
APPLICATION NOTE - YOGURT STABILITY
SEDIMENTATION ANALYSIS

1. Introduction

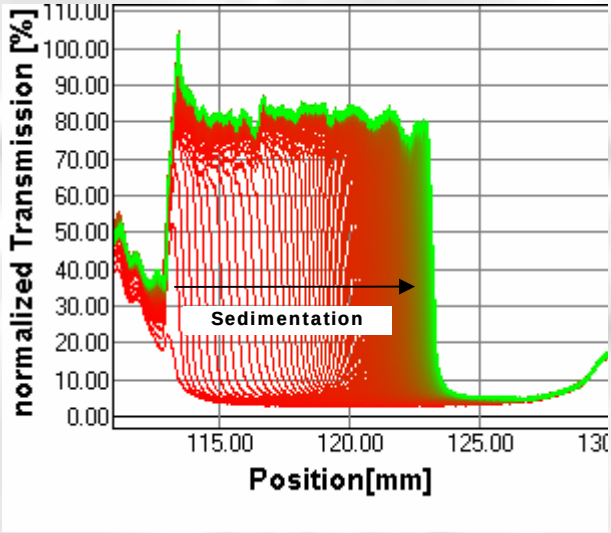
Yogurt is a fermented dairy product made by adding bacterial cultures to milk, which causes the transformation of the milk's sugar, lactose, into lactic acid. This process gives yogurt its refreshingly tart flavor and unique pudding-like texture, a quality that is reflected in its original Turkish name, Yoghurmak, which means "to thicken."[1]
A variety of yogurts available from the supermarket has been investigated to determine the demixing behaviour. Sedimentation analysis based on multisample analytical centrifugation, applying the STEP®-technology, provides a tool for comprehensive qualitative and quantitative analysis of yogurt.

2. Results

2.1 Fingerprinting of yogurts – Low fat content



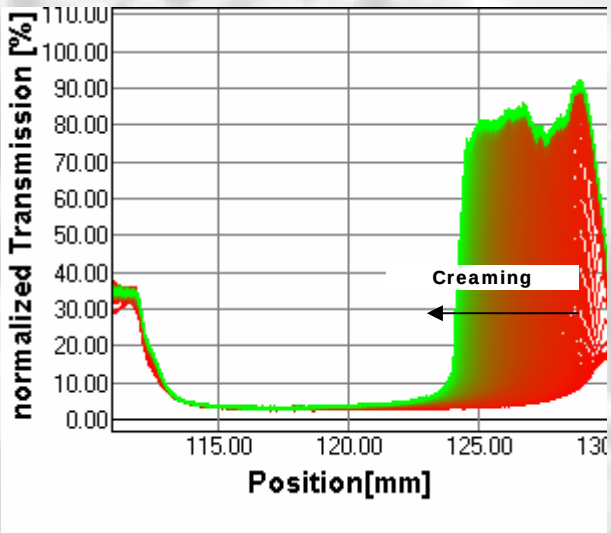
Yogurt 0.1% fat, evolution of transmission profiles with time at 2300 xg, 25 °C.



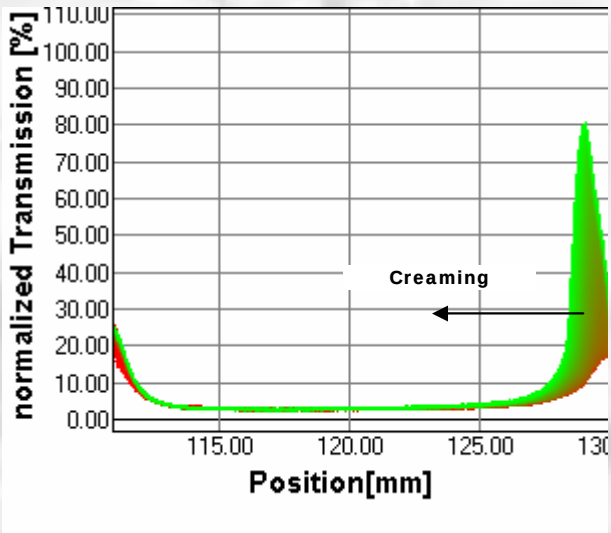
Yogurt 3.5% fat, evolution of transmission profiles with time at 2300 xg, 25 °C.

The evolution of the transmission profiles for all samples with a fat content from 0.1 % up to 3.8 % characterizes mainly zone sedimentation and consolidation of a particle network, as shown in the examples above. All particles move with the same speed for sample at the right, whereas for the sample at the left an additional clarification due to separate sedimentation of finer particles can be seen clearly. The space between the consecutive profiles decreases, the resistance against further compaction of a space filling particle network is increasing. Increasing the fat content from 0.1 % to 3.8 % separation stability increases (smaller difference between two consecutive profiles).

2.2 Fingerprinting of yogurts – High fat content



Yogurt 9.4 % fat, evolution of transmission profiles with time at 2300 xg, 25 °C.



Yogurt 10 % fat, evolution of transmission profiles with time at 2300 xg, 25 °C.

The evolution of the transmission profiles for yogurt containing 9.4 % and 10 % fat characterizes creaming and consolidation of a particle network, as shown above.
All particles move with the same speed. The space between the consecutive profiles decreases, the resistance against further compaction of a space filling particle network increases. As obvious the yogurt with a nominal fat content of 10 % is far more stable.

2.3 Separation extent - Comparison of all yogurts

The separation extent and kinetics can be easily compared and quantified for the samples using the analysis mode 'front tracking' (sedimentation front traced at a certain constant transmission value), the extent of the aqueous phase separation is used for a relative comparison for all samples, see table.

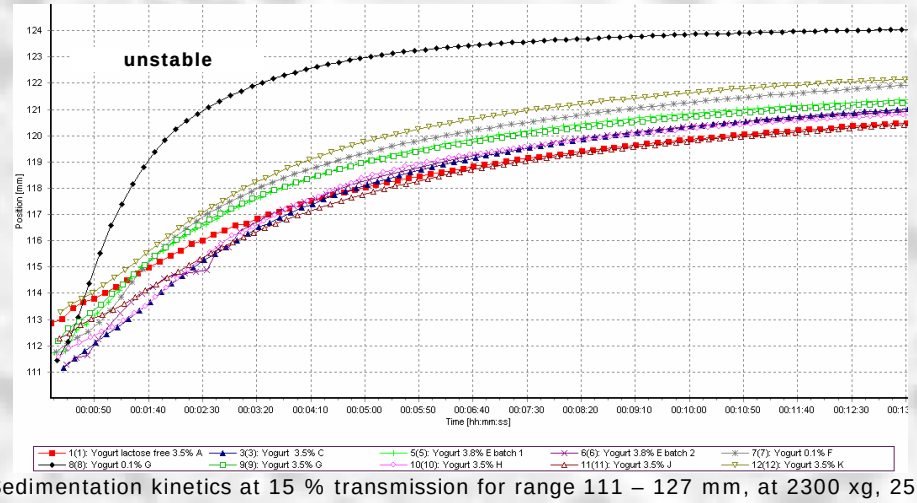
Yogurt type with fat content and producer [A-K]	Extent of aqueous phase separation [ratio of clear phase / total sample height]
Yogurt 0.1% G	0.74 (unstable)
Yogurt 0.1% F	0.72
Yogurt 3.5% K	0.64
Yogurt 3.5% C	0.63
Yogurt 3.8% E batch 2	0.62
Yogurt 3.5% H	0.61
Yogurt 3.5% G	0.61
Yogurt 3.8% E batch 1	0.60
Yogurt 3.5% J	0.58
Yogurt lactose free 3.5% A	0.54
Yogurt greek style 9.4% B	0.32
Yogurt greek style 10% D	0.07 (stable)

Centrifugation for 42 min at 2300 xg, 25°C, separation of aqueous phase detected at 15 % transmission.

Yogurt containing low fat (0.1 %) shows the largest extent of water separated (most unstable), while yogurt containing 10 % fat is the most stable against demixing under the applied conditions.

2.4 Sedimentation kinetics

The detailed analysis of the sedimentation kinetics is obtained applying the front tracking mode, following the movement of the phase border supernatant-particle containing phase, at a transmission value of 15 %. Sample 0.1 % G has the highest corresponding sedimentation velocity (slope within the initial range of the curves) and is the most unstable.



Sedimentation kinetics at 15 % transmission for range 111 – 127 mm, at 2300 xg, 25 °C

The samples can be distinguished referring to the sedimentation velocity within the first minutes.

2.5 Comparison of two batches with different shelf life

Two yogurts of identical type and producer but with different shelf life were compared. Batch 1 had a *Best before date* of 10 days after the purchase date and batch 2 had a *Best before date* of 16 days after purchase on the same day.
Both samples were measured at 4°C immediately after purchase, after aging for one day at 25°C and after aging for three days at 25°C. The calculated sedimentation rates (front tracking at 15 % transmission for the range 108 – 123 mm, following the sedimentation within the first 150 sec) are compared in the following table.

	Sedimentation rate at 2300 xg [µm/sec]	StdDev [µm/sec]	Corr. coeff.
Yogurt 3.8% E 10 days shelf life, 4°C	23.0	0.4	0.999
Yogurt 3.8% E 16 days shelf life, 4°C	22.2	0.4	0.998
Yogurt 3.8% E 10 days shelf life, aged 1 day 25°C	36.8	1.1	0.994
Yogurt 3.8% E 16 days shelf life, aged 1 day 25°C	32.3	2.1	0.974
Yogurt 3.8% E 10 days shelf life, aged 3 days 25°C	33.0	0.4	0.999
Yogurt 3.8% E 16 days shelf life, aged 3 days 25°C	30.7	0.4	0.999

The fresh product with a shelf life of 16 days shows lower sedimentation rates at all times, i.e. a higher stability.

3. Summary

Multisample analytical centrifugation, applying the STEP®-technology, provides a powerful tool for comprehensive qualitative and quantitative analysis of yogurt. Sedimentation and creaming is detected simultaneously. The extent of the separated aqueous phase, the sedimentation or creaming rate give information on the stability of the yogurt samples.

4. References

- [1] http://www.whfoods.com/genpage.php?tname=foodspice&dbid=124, available 19.2.2008
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