INFLUENCE OF STORAGE CONDITIONS ON THE RHEOLOGICAL PROPERTIES OF DAIRY PRODUCTS

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INTRODUCTION

Dairy products – especially fermented products as yoghurts, yoghurt drinks and sour milk – are very popular with the Austrian population. The healthy properties as well as the pleasing texture are main reasons. The texture – also responsible for a pleasing mouth feel – is caused by a bundle of structure related properties of which the viscous and visco elastic ones are the base to the presented study.

MATERIALS

Four samples of dairy products (purchased locally) were selected representing the Austrian market. They were chosen for their differences in texture and fat contents. The samples were:

Natural stirred yoghurt - 1% fat
Natural stirred yoghurt - 3,6% fat
→ **More solid samples**

Buttermilk - 1% fat
Sour milk - 3,5% fat
→ **More liquid samples**

OBJECTIVES

The aim of the performed experiments was to monitor eventual occurring structure changes of the different diary products during a defined storage time and storage temperature (4°C) to predict possible influences on migration of additives from packaging materials. The storage time was 14 days for yoghurts, 28 days for buttermilk and sour milk. The development of structure changes should be described by rheological and visco-elastic characteristics.

METHODS

A set of characteristics was determined every week of each sample in order to examine developing changes. All experiments were performed using a MCR 301 rheometer (Anton Paar) equipped with a 50 mm plate-plate geometry (gap = 1 mm).

Rotational Rheometry (CSS – Mode: τ = 0….100 Pa; T = 5°C) → yield stress τ_0

Oscillatory Rheometry:

Amplitude sweep (γ = 0,1…100 %; ω = 1 rad/s; T = 5°C) → linear viscoelastic range (LVR), flow point τ_F , storage and loss moduli G' and G''

Frequency sweep (ω = 10….0,1 rad/s; γ = 0,5 %; T = 5°C) → gel structure (long time and short time behaviour)

Temperature cycle test (T = 3....20°C 5 cycles; γ = 0,5 %; ω = 1 rad/s)

→ structure stability under temperature changes

RESULTS

Sample	τ_0(t1) [Pa]	τ_0(t2) [Pa]	LVR (t1) [%]	LVR (t2) [%]	G' (LVR, t1) [Pa]	G' (LVR, t2) [Pa]	G'=G'' (t1) [Pa]	G'=G'' (t2) [Pa]	τ_F(G'=G'',t1) [Pa]	τ_F(G'=G'', t2) [Pa]
Yoghurt 1% fat	34 ± 2	29 ± 2	1,1 ± 0,2	1,1 ± 0,1	302 ± 18	367 ± 8	36 ± 8	41 ± 1	27 ± 6	29 ± 2
Yoghurt 3,6% fat	44 ± 2	43 ± 3	1,2 ± 0,1	1,3 ± 0,3	415 ± 34	414 ± 52	45 ± 5	43 ± 5	33 ± 5	31 ± 4
Buttermilk 1% fat	12 ± 1	8 ± 1	1,5 ± 0,1	1,0 ± 0,1	104 ± 3	48 ± 3	13 ± 1	4 ± 1	10 ± 1	4 ± 1
Sour milk 3,5 fat	10 ± 1	20 ± 1	1,2 ± 0,1	0,9 ± 0,1	111 ± 4	95 ± 19	10 ± 1	8 ± 2	6 ± 1	5 ± 1

CSS – mode (rotation) (columns τ_0(t1), τ_0(t2)) **Amplitude sweep** (LVR to τ_F columns)

Sample	G' (0,1 rad/s, t1) [Pa]	G' (0,1 rad/s, t2) [Pa]	tan δ (t1)	tan δ (t2)	G' (3°C, t1) [Pa]	G' (20°C, t1) [Pa]	G' (3°C, t2) [Pa]	G' (20°C, t2) [Pa]
Yoghurt 1% fat	151 ± 17	168 ± 12	0,256	0,258	226 ± 2	124 ± 4	247 ± 2	134 ± 4
Yoghurt 3,6% fat	262 ± 33	253 ± 16	0,259	0,261	270 ± 4	133 ± 2	311 ± 3	155 ± 4
Buttermilk 1% fat	46 ± 5	67 ± 1	0,260	0,256	62 ± 1	33 ± 1	126 ± 1	68 ± 1
Sour milk 3,5 fat	59 ± 3	76 ± 10	0,280	0,284	87 ± 7	45 ± 2	146 ± 1	75 ± 1

Frequency sweep (G' (0,1 rad/s) and tan δ columns) **Temperature cycle test** (G' (3°C/20°C) columns)

The obtained results draw different pictures for yoghurts (the more solid samples) and the more liquid samples buttermilk and sour milk.

Yoghurts were very stable in all their structure parameters during the observed period. Even the multiple temperature changes from refrigerator coolness to room temperature did not harm the storage modulus much (see temperature cycle test).

However the liquid samples buttermilk and sour milk exhibited some variance in the characteristics over the time.

The τ_0 determined obtained from the gamma-tau diagrams stayed constant for the yoghurts but increased in sour milk 2 weeks after the best-before-date and decreased in buttermilk 3 weeks after the best-before-date.

The linear visco elastic range (LVR) of all samples did not change significantly. Only in the case of buttermilk and sour milk the moduli (storage modules G' and loss modules G'') decreased during the time.

The frequency sweep lead to similar loss factors tan $\delta \approx$ 0,26 for all samples which is likely to be an indication for the similar gel structures formed by the casein networks. G' and G'' of the yoghurts were staying constant but G' of buttermilk and sour milk increased.