CONSISTENCY MEASUREMENTS WITH TWO DIFFERENT RHEOLOGICAL METHODS FOR THE CHARACTERIZATION OF SET YOGHURT, PRODUCED WITH ADDITIVES OF NATIVE WHEY PROTEINS

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1. Introduction

Texture and rheological attributes are among others important properties of yoghurt products. The consistency determination of the weak yoghurt gel network by rheological methods is problematic because the structure to measure can partly be damaged already in the act of sample preparation. No standardised rheological methodology (e.g. IDF, ISO) for set yoghurt is available, therefore a method with minimal destruction of the weak structure before measuring is required, e.g. the vane measuring system or the cylinder penetration test.

For decades experts have been studying how whey proteins could be applied in food-systems. Undenaturated whey proteins are investigated as dietary aid (1) and offer several benefits as material to formulate yoghurt products. Patocka et al. (2) reported on textural effects of soluble whey protein isolate (WPI) added to stirred yoghurt. The WPI was added as a nutraceutical (***nutr***itional and pharm***aceutical***) rather than a technological ingredient at different levels (2-10%) to a commercially available stirred yoghurt, containing pectin and carrageenan. In this study (2) the apparent viscosity of the stirred yoghurt decreased with WPI concentration of 2-8%. In contrast, additions of WPI of 8 to 10% led to an increase of the apparent viscosity.

The objectives of this study were

1) to measure the rheological characteristics of different set yoghurts with a vane directly in the yoghurt cup "as it is" with a minimum of destruction of the weak structure before the measurement and to compare the results with those of the cylinder penetration method and

2) the study and the quantification of the effect of native whey protein to the structure of set yoghurt. The native whey protein (3-12%) was added to the yoghurt-milk just before fermentation.

2. Materials and methods

2.1 Materials: The coagulation of milk is a process, where physical and rheological properties are changing dramatically. A process (homogenising at 65°C, heating over 90°C, cooling down to 46°C and lowering the pH below 4.6) is usually used for the production of yoghurt and therefore was likewise applied in our study. The production of the set style yoghurts was carried out in the pilot plant at ALP (Liebefeld). Native whey protein was added just before fermentation in the concentrations of 0 (control) to 12%.

2.2 Chemical composition and pH

Routine chemical analyses were carried out to determine fat, protein, lactate, dry matter and pH-value.

2.3 Rheological methods

2.3.1 Cylinder penetration (universal testing machine): The cylinder penetration test was performed at constant speed using an "Universal Testing Machine" Zwick Z2.5/TN1S (Zwick, Ulm, Germany) equipped with a 500 N force sensor and an acrylic cylinder (h = 35 mm, **f** = 25.4 mm). E-modulus and the required force at a defined penetration (e.g. 35 mm), often called the "firmness", were determined.

2.3.2 Vane rheometry (rotation-oscillation rheometer): A low and large amplitude dynamic oscillation test (amplitude sweep) was performed with a Physica MCR 300 (Physica, Stuttgart, Germany) equipped with a vane (ST14). G' and G'' in the linear-viscoelastic range (LVE) were determined and the "yield stress" at the cross over of G' and G'' was calculated (3).

3. Results and Discussion

3.1 *Composition:* After 6 days of storage at 5°C, the pH values increased in direct proportion to the percentage of added whey protein, due to the buffer properties of the whey proteins.

3.2 *Cylinder penetration:* The E-modulus and the force at 35 mm were inversely proportional to the amount of native whey protein added.

3.3 *Vane rheometry:* Rheological measurements of yoghurt feature a variety of non-newtonian effects, such as viscoelasticity, time-dependency, yield stress and shear-thinning. Because of the time-dependency behaviour, low and large amplitude dynamic oscillation was performed. The amplitude sweep measures elastic and viscous moduli (G' and G'') in the linear and non-linear viscoelastic regime. Both G', G'' and yield stress values were inversely proportional to the amount of native whey protein levels. Values from the cylinder penetration test correlated well to the amplitude sweep:

1: Inside the LVE: E-modulus (cylinder penetration test) correlated well with the rheological values from small amplitude dynamic oscillation like G' and G'' and negatively with the concentration of lactate, fat, protein, dry matter and the pH-value as outlined in table 1.

2: Outside the LVE: The force at 35 mm (cylinder penetration test) correlated well (Figure 1) with the rheological values determined by large amplitude dynamic oscillation properties like the yield stress value as calculated from G'-G'' cross over.

The addition of native whey protein (3-12%) to the yoghurt-milk after heating led to a remarkable reduction of the force (at 35 mm), of G', G'' and yield stress values as compared to the control; even the dry matter was clearly increased. Native whey protein was not supportive of the structure, on the contrary it acted as a "structure breaker" (4).

4. Conclusion

The two compared measuring methods give evidence to a reasonable good agreement. Native whey protein added to the yoghurt before fermentation lowered the force at 35 mm and the yield stress values remarkably giving rise to an increasingly softer texture. The vane geometry offers three main advantages:

- it minimizes damage during sample preparation
- it avoids wall-slip
- the sample preparation is reproducible

Disadvantageous is the fact, that the vane geometry cannot produce any "absolute" values, because it is a "relative measuring system".

5. REFERENCES

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Table 1: Correlation inside the LVE

	E-Modulus [N/mm^2]
G' (LVE)	0.998
G''(LVE)	0.999
pH	-0.984
Lactate	-0.993
Fat	-0.995
Protein	-0.996
Dry matter	-0.997

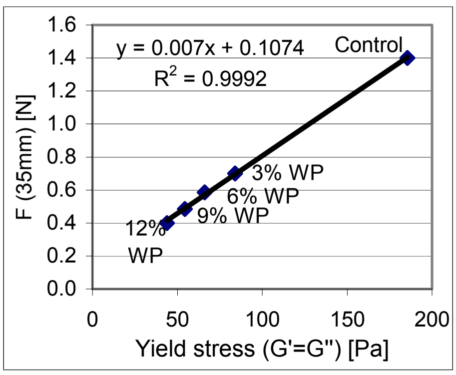

Fig. 1: Correlation of yield stress determination and force at 35 mm for all yoghurts (0% - 12% whey protein, r=0.999)