# THE RHEOLOGY OF BUTTER

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# Abstract.

A parallel plate viscoelastometer was built to perform creep compliance tests on butter and related fats. Creep movement was measured with a linear displacement transducer and recorded by a data logger designed and built for creep compliance experimentation.

A temperature of $10^{O}C$ was maintained by placing the parallel plate viscoelastometer in a refrigerated incubator.

A series of preliminary experiments established the creep response was linear and that the direction in which some samples were sheared was critical. The duration of creep compliance testing was also found to affect results.

Creep behaviour of butter was assumed to be viscoelastic (based on previous studies) and was modelled with a generalized Kelvin model. Elastic and viscous parameters were fitted to the data by a Marquadt non-linear least squares curve algorithm. Continuous retardation spectra were found by plotting $L(\tau)$ against ln time. Data which had been both smoothed and differentiated by the methods of Savitzky and Golay (1964) showed evidence of the existence of three or four main groups of retardation mechanisms.

On removal of stress after creep compliance testing a partial recovery of strain was observed, however, samples failed to recover as much as predicted by viscoelastic theory. A second creep/recovery cycle resulted in a responses similar in magnitude to the first recovery. All fat products tested showed the same pattern of response on repeated creep/recovery cycling.

An explanation, based on the behavior of polymers, was put forward to explain the observed pattern of response. The crystal network was thought to align in the direction in which stress was applied. The formation of new 'bonds' was then thought to lock the network in its' new position.

A number of samples were reworked, The creep curve seen on creep/recovery cycling of reworked samples was similar in shape to that seen for the original samples. However, the curves were three to four times greater than those seen for the original samples. In general, creep response was found to be inversely proportional to hardness.

The retardation spectra of reworked samples differed from those seen for the original samples in several ways. The spectra were smoother, the bulk of the spectra had moved to shorter times and they were larger than those seen for the original samples.

A survey of seasonal butter samples was also undertaken. Creep compliance parameters were found to correlate well with sectility hardness and solid fat content.

# Aim of Study.

The aims of this work are:

a) To study the rheological properties of butter and related fat products by a creep compliance method.

b) To gain a clearer understanding of the relationship between rheological properties, composition and structure of butter and related products.

c) To use this knowledge to improve the rheological properties of butter.

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