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Letter to the Editor

Comment on *Measurement of the rheology of polysaccharide gels by penetration* by C.M. Gregson, S.E. Hill, J.R. Mitchell, & J. Smewing, *Carbohydrate Polymers*, 38 (1999) 255–259

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Gregson, Hill, Mitchell and Smewing (1999) (GHMS) have recently commented on our method for measuring the absolute shear modulus of a gel from a simple penetration test (Oakenfull, Parker & Tanner, 1989). In this method a probe of cylindrical cross-section (radius r) is inserted into a gel held in a cylindrical vessel (radius R). The absolute shear modulus is obtained from the apparent Young's modulus (stress/strain) multiplied by a constant factor that depends only on the geometry of the apparatus. The calculated modulus should thus be independent of r/R. GHMS confirmed that for gelatin gels, the calculated modulus was indeed independent of r/R, but for polysaccharide gels (alginate and carrageenan), the method apparently failed and the calculated modulus decreased with increasing r/R.

The reader could be left with the impression from this result that shear modulus data from penetration tests are always questionable for polysaccharide gels. However, we believe that our method delivers reliable data for any gel system (including polysaccharides) *when used appropriately*. For example, Fig. 1 shows a plot of shear modulus (G, measured by penetration) or storage modulus (G', measured at 1 rad/s using a Rheometrics Dynamic Stress rheometer) against concentration for the same sample of κ-carrageenan. The G and G' data lie on the same curve.

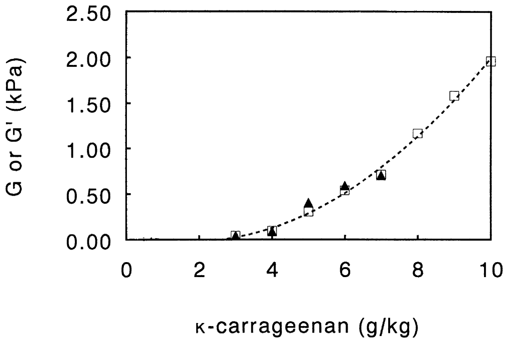

Fig. 1. Plot of absolute shear modulus (G, ▲) and storage modulus (G', □) at 15°C plotted against concentration for the same sample of κ-carrageenan (Sigma). The shear modulus data were obtained by penetration using a probe of radius 1.5 mm, a cylindrical container of radius 12.5 mm with a conversion factor $f = 0.0208$ (see text). The storage modulus data were measured at 1 rad/s using a Rheometrics Dynamic Stress Rheometer with parallel plate geometry (radius 25 mm).

Our paper describing the penetration method (Oakenfull et al., 1989) gives a full account of the limitations of the method and the theory behind it. We explicitly state that we are dealing with an incompressible elastic solid undergoing small deformations. We suspect that the probe speed (0.5 mm/s) used by GHMS was too high. We also used 0.5 mm/s (for the small dish system) but in bursts of 5 s followed by 55 s relaxation before recording the equillibrium applied force, i.e. an effective speed of only 0.0417 mm/s. The weak gelatin gels studied by us and GHMS appear to relax faster than the polysaccharide systems. It seems likely that this is the cause of the differences GHMS observed between gelatin and the two polysaccharide systems.

In summary, we believe the penetration method delivers reliable values for G for all weak gel systems (gelatin and polysaccharides alike) provided that the material is subject to small deformations carried out slowly enough to minimise kinetic effects.

References

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Oakenfull, D. G., Parker, N. S., & Tanner, R. I. (1989). Method for determining absolute shear modulus of gels from compression tests. *Journal of Texture Studies*, *19*, 407–417.

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