



Phase diagrams in *kappa*-carrageenan/locust bean gum systems

P.B.Fernandes¹, M.P.Gonçalves² and J.L.Doublier³

¹*Escola Superior de Biotecnologia, Universidade Católica Portuguesa, Rua Dr António Bernardino de Almeida, 4200 Porto, Portugal,* ²*Instituto Nacional de Investigação Científica, Centro de Engenharia Química, Rua dos Bragas, 4099 Porto Codex, Portugal* and ³*INRA, Rue de la Géraudière, BP 527, 44026 Nantes Cédex, France*

Abstract. Gelation (T_{gel}) and melting (T_m) temperatures of *kappa*-carrageenan gels and 4:1 *kappa*-carrageenan/locust bean gum mixed gels, at different total potassium concentrations (C_T), were determined by means of rheological (dynamic and viscosimetric) measurements. The $\log C_T$ was linearly related to T_{gel}^{-1} and T_m^{-1} . Differences found between both systems are discussed.

Introduction

Kappa-carrageenan and locust bean gum (LBG) are known to form thermo-reversible and synergistic gels when mixed (1,2). This property has found widespread use for its technological applications mainly in the food industry. The aim of the present work was to study the variations of the gelation (T_{gel}) and melting (T_m) temperatures as a function of potassium concentration in the mixed *kappa*-carrageenan/LBG systems. These experiments were performed at the 4:1 ratio which had been found to yield the maximum synergistic effect (3). The results were compared to those of *kappa*-carrageenan alone.

Materials and methods

One commercial grade locust bean gum flour was kindly provided by INDAL (Portugal). The *kappa*-carrageenan sample was extracted from *Eucheuma cottonii* and was kindly supplied by SBI (France). INDAL commercial gum was purified by isopropanol precipitation. The *kappa*-carrageenan sample, in the K^+ form, was used without further purification.

The gels were prepared by mixing, at 90°C, solutions of LBG and *kappa*-carrageenan at a given potassium concentration. The hot mixture was poured directly onto the plate of the rheometer or in the viscometer cup. Cooling and heating rates were 18°C/h. T_{gel} and T_m were determined by means of dynamic measurements using a Carri-Med controlled stress rheometer for the highest concentrations, and of viscosity measurements, using a Low Shear 30 viscometer (Contraves), for the lowest ones. The temperatures (T_{gel} and T_m) at which the sol/gel transitions occurred were defined by the departure point of the plots of G' (storage modulus)(Figure 1) and relative viscosity (Figure 2) versus temperature.

Results

The T_{gel} and T_m values obtained for *kappa*-carrageenan alone and the 4:1

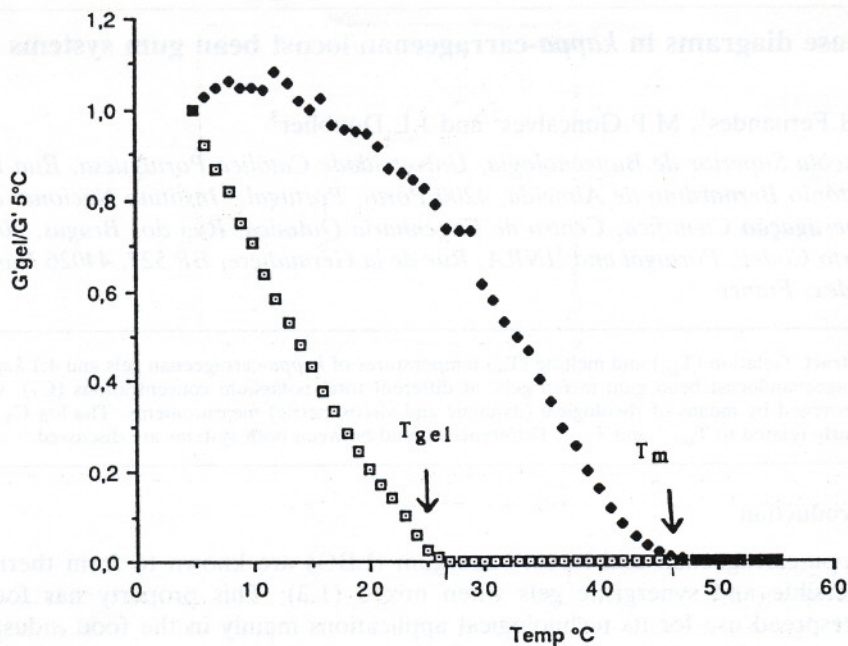


Fig. 1. G' variation as a function of temperature in a *kappa*-carrageenan/LBG 4:1 mixed system (1% total polymer concentration). \square = cooling curve; \blacklozenge = heating curve.

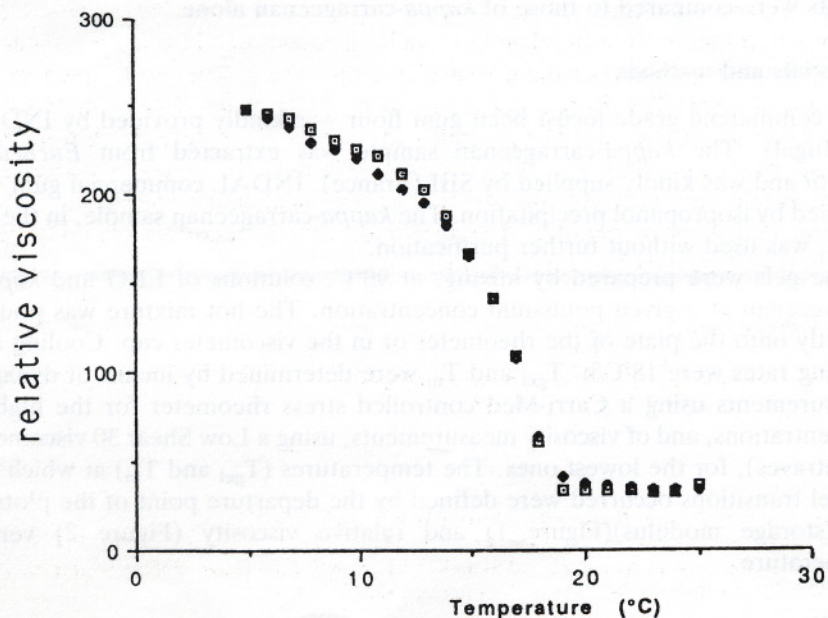


Fig. 2. Relative viscosity as a function of temperature in a *kappa*-carrageenan gel (0.5% polymer concentration); same legend as in Figure 1.

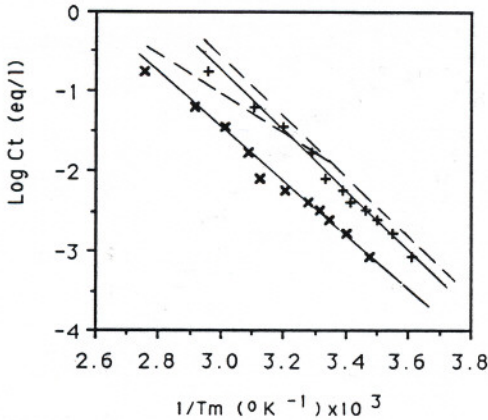


Fig. 3. Log C_T versus T_m^{-1} and T_{gel}^{-1} for a *kappa*-carrageenan/LBG 4:1 mixed system (continuous lines); comparison with *kappa*-carrageenan alone (dashed lines).

mixture are presented in Figure 3. For both systems, the logarithm of the total potassium concentration C_T was linearly related to T_{gel}^{-1} and T_m^{-1} . For *kappa*-carrageenan alone the results were quite close to those obtained by Rochas and Rinaudo (4). For the mixture it was observed that T_{gel} was slightly higher than for the *kappa*-carrageenan. However, a more dramatic difference was found for T_m , the mixture displaying much higher values than the *kappa*-carrageenan alone. The temperatures of gelation of *kappa*-carrageenan and 4:1 mixture indicate that the mechanism of gelation in both cases should be similar, meaning that it is the *kappa*-carrageenan that establishes the gel network, even in the presence of LBG. The differences found at the T_m between the two systems can be ascribed to the increase of gel rigidity in the mixed systems which is induced by the presence of LBG. However, oscillatory shear and viscosimetric measurements can only give information on the mechanical properties of these systems and a more detailed description of the mechanisms would require further investigations by other methods.

Acknowledgements

Financial support is gratefully acknowledged from JNICT (Lisbon) and from NATO (project POPORTOFOOD).

References

1. Rees, D.A. (1969) *Adv. Carbohydr. Chem. Biochem.*, **24**, 276–332.
2. Dea, I.C.M. and Morrisson, A. (1975) *Adv. Carbohydr. Chem. Biochem.*, **31**, 241–312.
3. Fernandes, P.B., Gonçalves, M.P. and Doublier, J.L. (1990) *Carbohydr. Polymers* (in press).
4. Rochas, C. and Rinaudo, M. (1980) *Biopolymers*, **19**, 1675–1687.