**Interaction networks of ulvan-based mixed systems**

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In contributing to provide broader applicability of ulvan, our current study evaluated the rheological behaviour in mixed ulvan-carrageenan (UL/KC), ulvan-funoran (UL/FUN) and ulvan-gelatin (UL/GLT) systems. Ulvan as known, is a heterogeneous anionic polysaccharide that generally forms weak soft gels which is mostly enhanced by the addition of boric acid 1,2. The aim of the current study however, was to analyze the interaction mechanisms of these ulvan-based systems by testing the influence of different mixing ratios, pH conditions and cations for prospective food-related applications.

For this, four different fractions of ulvan isolated from *Ulva lactuca* under either hot or cold conditions and precipitated using either NaCl or ethanol were used as UL samples. It was observed that, the uronic acid and sulfate composition of ulvan specifically influence the rheological behaviour of ulvan systems. In native ulvan fractions with no added salts, ethanol-precipitated ulvans formed relatively viscous solutions than NaCl-precipitated fractions. Adding 0.12 M CaCl2 to ulvan however, increased the complex viscosity (η) of NaCl-precipitated fractions which contained higher sulfate content. A similar effect was observed in mixed UL/GLT systems where using porcine gelatin, yielded up to ~1500 mPa.s viscous solutions. The differences in the recorded complex viscosity and storage modulus (G') of UL/GLT samples during the cooling and reheating stages rather suggested levels of aggregation at lower temperatures. As expected of gelatin, the influence of isoelectric point (ISP) was evident in the different tested pH ranges. UL/GLT systems prepared using gelatin at pH < 7 reported values of G' higher than at pH > 7. In UL/KC systems, complex viscosity ranging up to ~3000 mPa.s was recorded. Under these mixing conditions, the viscoelastic behaviour of UL/KC decreased with decreasing volume ratios of KC. Additionally, increasing amounts of KC increased the melting temperature (Tm) in UL/KC. This simply indicated a dependency of this network on the aggregation of the molecular chains of KC. In UL/FUN systems, the influence of Ba2+ ions which is known to induce gelation in funoran recorded G′ (4℃) between ~522 －618 Pa. Inasmuch as divalent cations like Ca2+ and Ba2+ showed levels of rheological influence in ulvan systems by bridging the charged units of the molecular chains, the induced impact in the tested binary systems is dominantly attributed to present co-solutes rather than the non-gelling isolated ulvan.

*References:*

1 Kidgell, J. T., Carnachan, S. M., Magnusson, M., Lawton, R. J., Sims, I. M., Hinkley, S. F., de Nys R., & Glasson, C. R. (2021). Are all ulvans equal? A comparative assessment of the chemical and gelling properties of ulvan from blade and filamentous *Ulva*. *Carbohydrate Polymers*, *264*, 118010.

2 Qiao, L., Li, Y., Chi, Y., Ji, Y., Gao, Y., Hwang, H., ... & Wang, P. (2016). Rheological properties, gelling behavior and texture characteristics of polysaccharide from *Enteromorpha* p*rolifera*. *Carbohydrate polymers*, *136*, 1307-1314.