

Elucidating the effect of molecular weight on the hierarchical network structure of binary mixed carrageenan gel

L. Geonzon^A, K. Mayumi^A

^A*ISSP-NSL, Univ. of Tokyo,*

Carrageenan is an important polysaccharide in food and biotechnological applications owed to its excellent gelation ability. There are several types of carrageenan, and the most commonly used are the κ -(KC), ι -(IC), and λ -(LC) carrageenan gels, which differ in the number and position of sulfate groups: one for KC, two for IC, and three for LC. Among the three important carrageenans, KC and IC are the commonly. Meanwhile, only the KC and IC are the gelling carrageenan. In addition, the gelation of carrageenan is affected by the temperature, cations and molecular weight of the polymers.

In many applications of carrageenan, a mixture of carrageenan with protein or other polysaccharides are often utilized to control the texture. However, the interaction of between polymer as it forms the gel network is very important to the final texture and mechanical property. A very common example of mixture of carrageenan with polysaccharides is through the mixtures of KC with its close relative IC or LC. Thus, in this study, the network structure of KC and IC or with LC with lower molecular weight is studied.

Figure 1 shows the intensity profile after circular averaging for carrageenan gels at different temperatures on cooling for: (A) KC, (B), KCIC (C) IC and their respective Kratky plots. At high temperatures, the intensity of all the samples is very low suggesting no structure is formed within the samples. This is because the carrageenan exists as a solution at this temperature conditions. Meanwhile, upon cooling a distinctive shoulder is formed attributed to the carrageenan aggregates as it forms double helices that make up the three-dimensional network structure. Furthermore, the shoulder formation is also very different for pure KC and pure IC sample implying the difference in the structure of between these gels. The increase in the intensity is very drastic with

shoulder formation extends up to the low q region for pure KC gels compared to the pure IC gels. Meanwhile, the peak position in the Kratky plot is different for both pure samples, implying that KC gels forms larger size aggregates compared to the pure IC gels. In addition, the KC gels form a more heterogeneous network compared to pure IC.

On the one hand, the mixtures of KCIC with almost similar molecular weight demonstrate a scattering pattern very similar to pure KC gel. This implies that in the mixtures, the scattering from the KC aggregates is dominate due to the size and density of the KC aggregates. Moreover, the shoulder extends up to low q suggesting the KC aggregates may form domains in the mixed gels attributed to the possible formation of KC-rich phase.

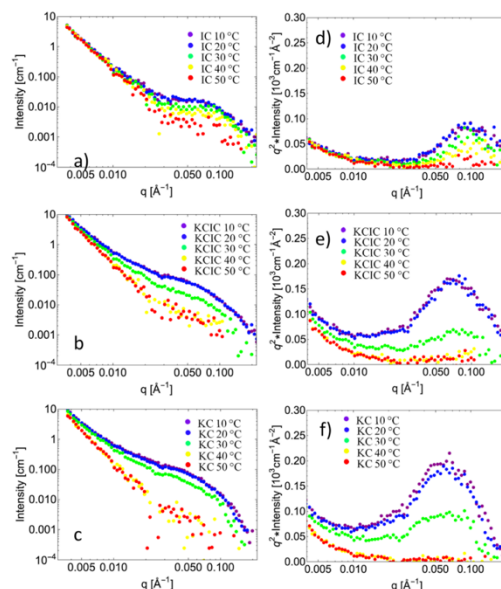


Fig. 1. 1D intensity profile of dual crosslinked carrageenan gel with (red) and without (blue) stretching. Reproduced from Ref. [1] from American Chemical Society.

[1] L. Geonzon *et al.*, *Macromolecules*, 56(21) 8676-8687, 2023.

