WYATT TECHNOLOGY

APPLICATION NOTE

AN1305: Irradiation-Induced Degradation of Sodium Alginate Studied by SEC-MALS

Summary

Sodium alginates are widely used as a food additive or as a sterile wound dressing. The molecular weight and conformation properties of this polysaccharide contribute directly to their end-use performance. When used as a thickening agent, the higher the molecular weight, the better the gel properties.

There has been considerable interest in recent years in the development of suitable test methods to characterize foods that have been irradiated to prolong shelf life. This note describes work undertaken on a grade of sodium alginate used as a food thickening agent, employing a DAWN® multi-angle light scattering (MALS) detector and Optilab® differential refractometer in conjunction with SEC, to determine the effect of gamma irradiation on the biopolymer.

SEC-MALS determines absolute molar mass, size and polymer conformation without relying on assumptions regarding column calibration standards or elution properties.

Experimental Conditions

A Waters 600 chromatograph was coupled to a HEMA Bio Linear column and downstream DAWN and Optilab detectors. Mobile phase was pure HPLC-grade water, run at a flow rate of 1.0 ml/min.

The alginate's specific refractive index increment, *dn/dc*, was measured off-line in the Optilab. The Optilab operates at the same wavelength as the DAWN, guaranteeing that the *dn/dc* value measured is applicable to MALS calculations as well as concentration determination.

Absolute molar mass (MW) and size (rms radius, R_g) at each elution volume were determined by analysis of the light scattering and refractive index signals in ASTRA®. After calculation of MW and R_g, ASTRA converted the data to differential MW distributions in and conformation plots.

Results and Discussion

The differential molecular weight distributions presented in Figure 1 clearly indicate the degradation in molecular weight (MW) that occurs after irradiation. The peak MW decreased by up to 70%, with a slight broadening and shift in overall distribution shape.

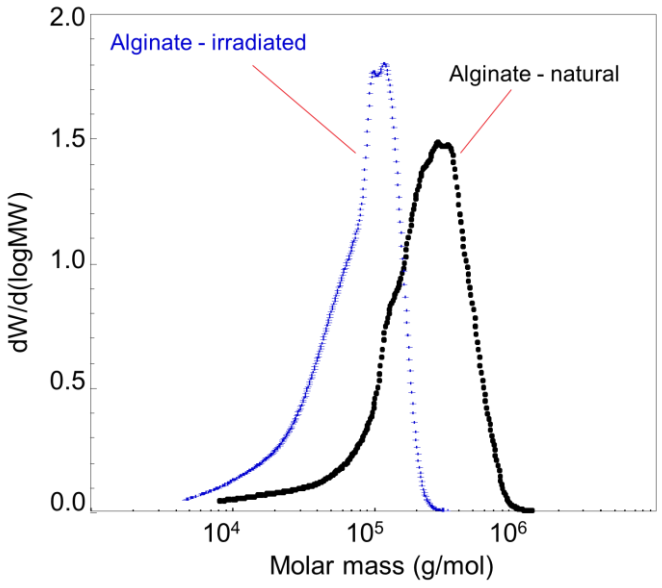

Figure 1. Differential molecular weight plots of sodium alginate before and after irradiation.

Of much greater interest, however, was the change in molecular conformation, shown in Figure 2. Multi-angle light scattering examines these changes by determining both the size and MW, independently, at each elution vol-

ume, then plotting log(R_g) as a function of log(M). The resulting slopes reveal whether the molecule's conformation is approximated by a sphere (slope of about 0.33), random coil (slope of 0.5-0.6) or rod (slope of 1.0).

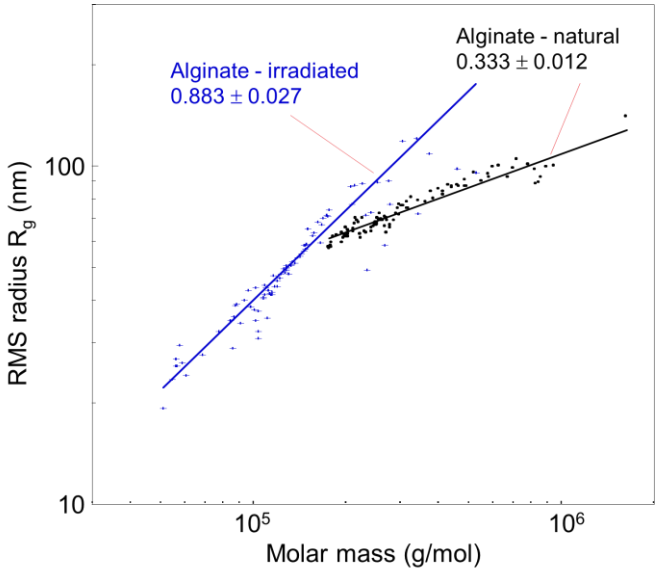

Figure 2. Conformation plot (RMS radius vs. Mw), before and after irradiation.

The conformation plot suggests that the natural, un-irradiated alginate has a compact, sphere-like structure. In the irradiated sample, by contrast, the slope of about 0.88 indicates that the molecules apparently have "opened" to a nearly rod-like structure.

The radiation dose given to the sodium alginate caused the molecule to change from a fairly dense, sphere-like, cross-linked structure to a rod-like conformation. This suggests that the cross-linking bonds are damaged or destroyed by the irradiation, causing the molecule to extend and/or expand, and hence modifying its performance as a food thickener or wound dressing.

Conclusions

SEC-MALS provides detailed information on the molecular weight and conformational changes induced in sodium alginate and similar polysaccharides by irradiation. The molecular-level changes may then be correlated to macroscopic changes in end-use performance for a deeper understanding of this phenomenon and the viability of such treatment.