

Structural Characterization of Alginate-Pectin Systems Crosslinked by Polyvalent Ions by ssNMR, FTIR and Factor Analysis

Martina Urbanova^{1*}, Ivana Sedenkova¹, Miroslava Pavelkova², Katerina Kubova² and Jiri Brus¹

¹ Department of Structural analysis, Institute of Macromolecular Chemistry, Czech Academy of Sciences, Czech Republic; urbanova@imc.cas.cz

² Department of Pharmaceutical Technology, Faculty of Pharmacy, Masaryk University Brno, Czech Republic

INTRODUCTION

Alginate and pectin are the most commonly used polyuronates due to their flexibility, biodegradability, biocompatibility, and non-toxic nature. These properties make cross-linked alginates and pectin essential for developing innovative solutions to various industrial challenges. While the gelation mechanisms of alginate and pectin, described by the egg-box model, were initially thought to be similar, research has revealed key differences in the formation and structure of egg-box dimers between the two. Consequently, this study aims to summarize the structural factors that influence the gelation behavior of alginate and pectin.

EXPERIMENTAL/THEORETICAL STUDY

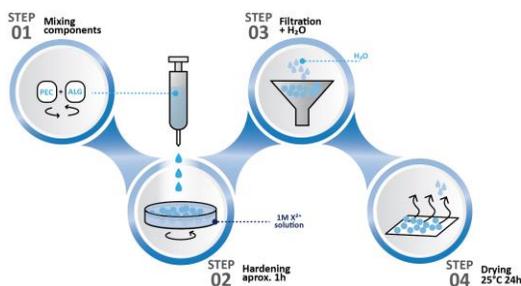


Fig. 1 Scheme of preparation alginate-pectin systems

$$Y_i = \sum_{j=1}^n w_j V_{ij} S_j$$

Y_i - residual errors
 w_j - singular value
 S_j - subspectra
 V_{ij} - coefficients

Fig.2 Equation of Principal component analysis/Factor analysis

By using of traditional techniques of solid-state NMR spectroscopy (¹H, ¹³C MAS and CP/MAS, ²³Na MAS NMR) and FTIR spectroscopy we monitored structural changes in alginate-pectin systems induced by different types of crosslinking ions such as Ca²⁺, Zn²⁺ and Cu²⁺.

Due to the strong overlap of spectral dates of alginates and pectin and the amorphous nature of these polysaccharides, direct visual interpretation of the spectra recorded for prepared (Fig.1) hybrid alginate-pectin gels is not always sufficiently reliable. For this reason, we used an independent approach based on principal component analysis (e.g. factor analysis) (Fig.2), which may reveal additional spectral features that appear to be hidden beneath the broadened resonance.

RESULTS AND DISCUSSION

Specifically, we focused on finding the key structural motifs that preferentially occur in the cross-linked polysaccharide matrix. We used the systematic interpretation subspectra S₁-S₅ and the corresponding V_{1j}-V_{5j} coefficients, which allowed us to understand the key structural motifs undergoing the changes in the alginate-pectin gels. Typically, the high-amplitude signals in the high-order subspectra of S₂-S₅ demonstrate the most prominent structural differences between the prepared networks.

CONCLUSION

The role of polyvalent ions cross-linking of alginate-pectin systems is then reflected in the single V_{ij} coefficients obtained from spectroscopic dates. The V_{ij} vs V_{ij} correlation plots illustrates the complex pathway of crosslinking reactions.

ACKNOWLEDGMENTS

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