WATER DYNAMICS IN HETEROPOLYSACCHARIDES BY MEANS OF NMR RELAXOMETRY

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Introduction

Pectin is used in food industry as gelling agent, thickener, and stabilizer in jams, jelly, fruit juices, bakery, milk and confectionary products.
One of the most important things to consider in that matter is water dynamics which contributes to products' stability and directly influences those products' quality.

Material and Method

Nuclear Magnetic Resonance (NMR) is a technique that was used to show the differences in water flow. NMR allows the user to get the insight about how the sample's hydrogen nuclei behave in different magnetic fields and how the magnetization of the sample changes over time.

Powdered pectins that were researched in this project were acquired from Kayseri Seker sugar factory, Kayseri, Turkey. Those pectins are a byproduct of sugar beetroot processing that uses variety of different techniques such as drying and precipitation. The powders were later used in creation of 10% and 20% water solution hydrogels that NMR relaxometry experiments were performed on.

Results

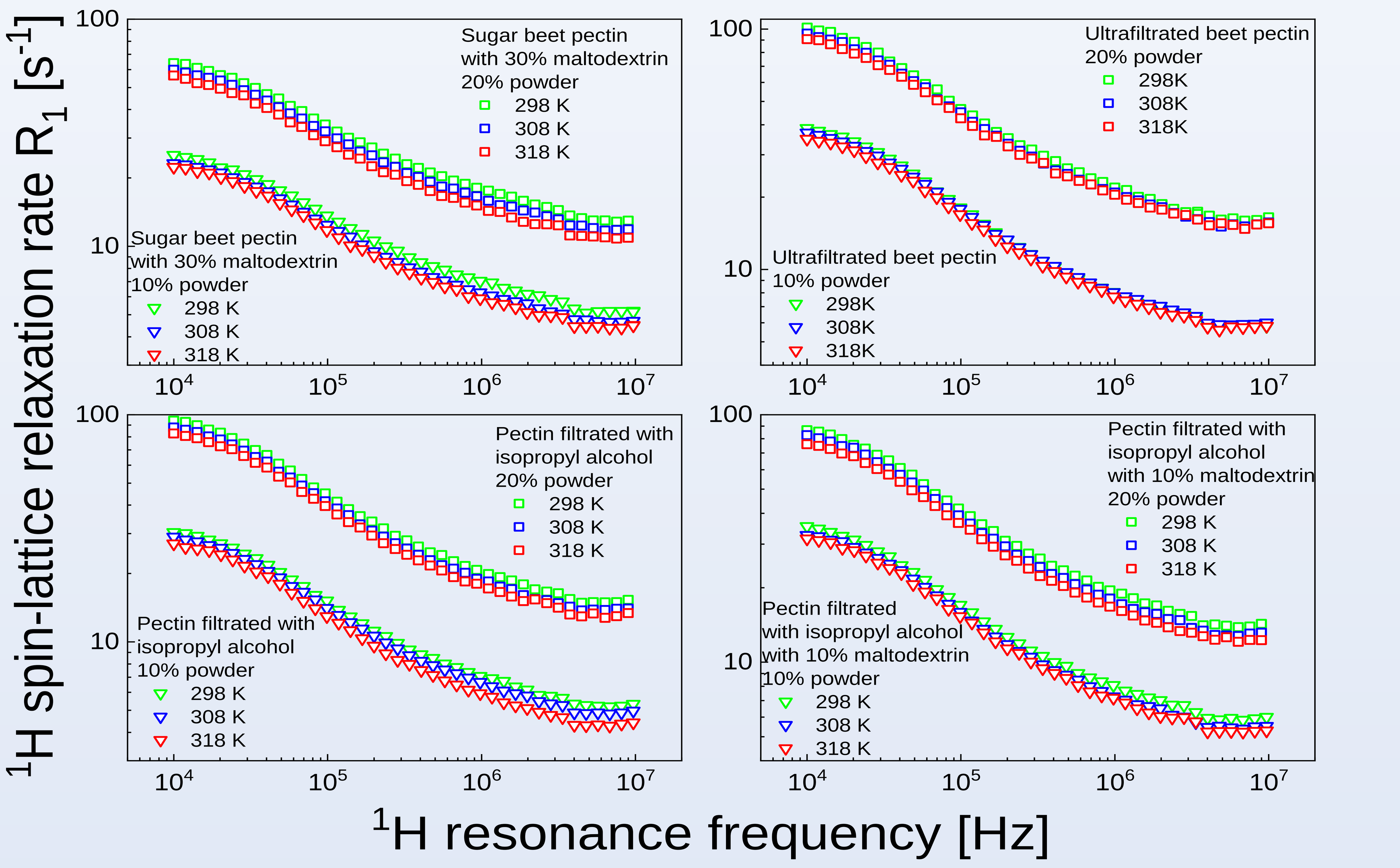

Fig. 1. ^{1}H spin-lattice relaxation rate profiles for pectins

Model of water dynamics

The molecular interactions between water molecules fluctuate in time. This time is known as corelation time. The corelation time shows how fast the system „forgets" it's original position- it describes the change of position in time caused by translational and rotational dynamics. The „memory" of the system deteriorates logarithimcally and proportionally to certain constants- dipolar relaxation constants in this case- dipolar relaxation constants.

$$R_1^{HH}(\omega_H) = C_s^{HH}\left(\frac{\tau_s}{1+\omega_H^2\tau_s^2}+\frac{4\tau_s}{1+4\omega_H^2\tau_s^2}\right)+$$
$$C_i^{HH}\left(\frac{\tau_i}{1+\omega_H^2\tau_i^2}+\frac{4\tau_i}{1+4\omega_H^2\tau_i^2}\right)+$$
$$C_f^{HH}\left(\frac{\tau_f}{1+\omega_H^2\tau_f^2}+\frac{4\tau_f}{1+4\omega_H^2\tau_f^2}\right)+A$$

C_s^{HH}- dipolar relaxation constant of slow dynamics
C_i^{HH}- dipolar relaxation constant of intermediate dynamics
C_f^{HH}- dipolar relaxation constant of fast dynamics
τ_s- corelation time of slow dynamics
τ_i- corelation time of intermediate dynamics
τ_f- corelation time of fast dynamics
ω_H- frequency
A- Frequency independent term

Analysis

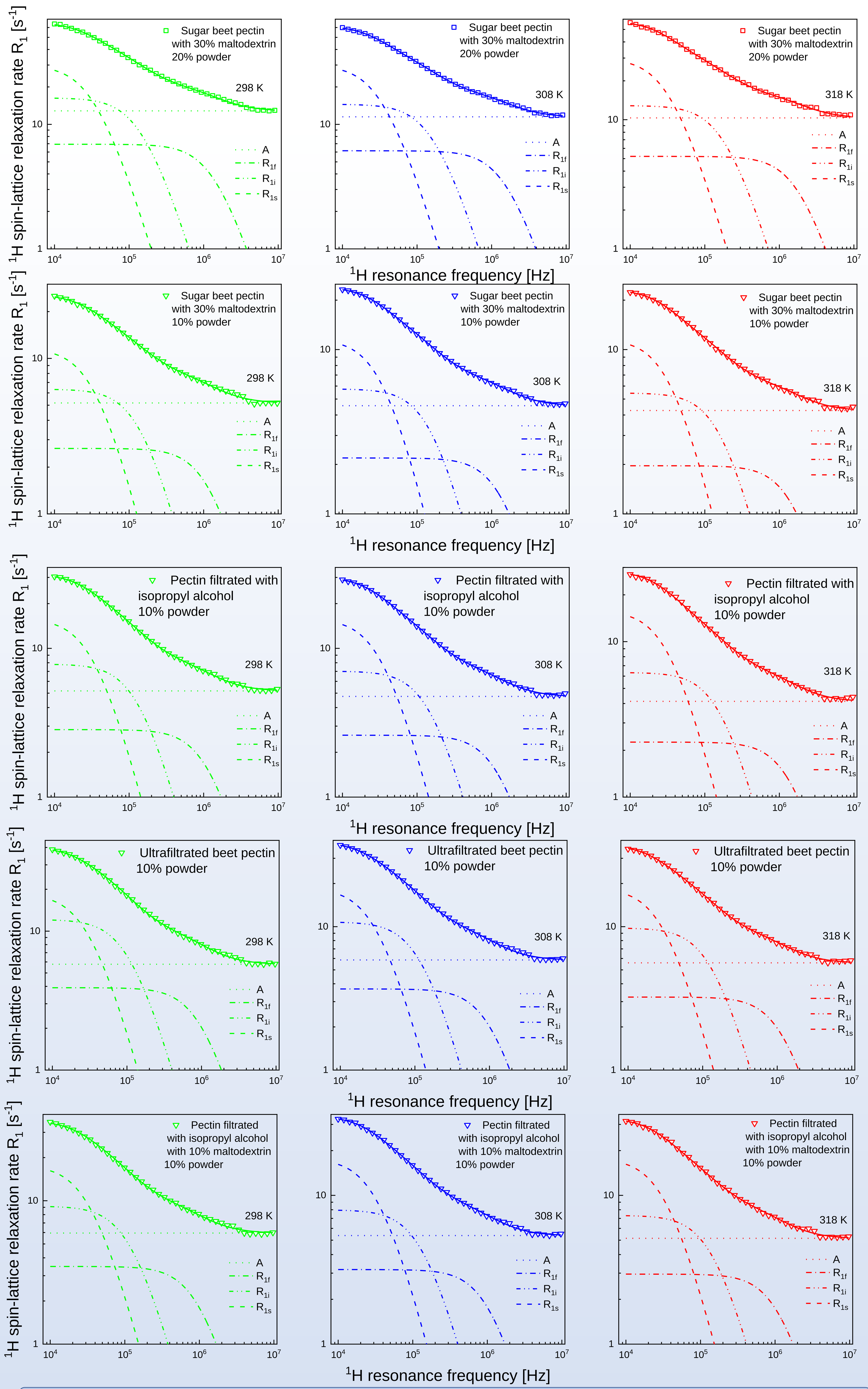

Fig. 2. Lorentzian distribution of pectin relaxation rate profiles examples

Conclusions

The water dynamics of water confined in pectin hydrogel can be split into fast, intermediate and slow dynamics. The relaxation rates differ slightly depending on temperature.

References

[1] D. Kruk, M. Wojciechowski, Y.L. Verma, S. K. Chaurasia, R.K Singh, *Phys. Chem. Chem. Phys.* **19**, 32605 (2017).
[2] D. Kruk, E. Masiewicz, S. Lotarska, R. Markiewicz, S. Jurga, *Int. J. Mol. Sci*. **23**, 1688 (2022).
[3] R. Meier, D. Kruk, A. Bourdick, E. Schneider, E.A. Rössler, *Appl. Magn. Reson.* **44**, 153 (2012).
[4] R. Meier, D. Kruk, J. Gmeiner, E.A. Rössler, *J. Chem. Phys.* **136**, 034508 (2012).
[5] D. Kruk, R. Meier, E.A. Rössler, *J. Phys. Chem. B* **115**, 951 (2011).

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SuChAQuality

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