Absolute Quantification and Localization of 23Na Bound Fraction by Double-Quantum Filtered NMR Spectroscopy and Imaging

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INTRODUCTION

It is well established that a high consumption of salt increases the risk of various diseases. However salt is added in transformed food for its bacteriostatic effect and its role for exhausting taste. The challenge for food manufacturers is then to reduce the added quantity of salt while guaranteeing the shelf life and keeping the sensory characteristics of transformed foods.

For this purpose, single-quantum (SQ) ^{23}Na NMR is a non-destructive quantitative method for measuring total salt content in foods. However, the latter method is not suited for distinguishing the different population of Na^+ ions on the basis of their binding states. Double-quantum (DQ) NMR is a solution for selecting Na^+ ions that experience anisotropic motions due to their interactions with ordered structures. We propose here DQ solutions for absolute quantification of bounded Na^+ ions by spectroscopy and for localizing such ions by imaging.

METHODS

The quantification of bounded Na^+ ions is based on a mathematical model which links ions concentration and NMR experimental parameters measured on acquired SQ and DQ spectra (Mouaddab 2007). A resin exchanging ions was used to control the concentration of bounded Na^+ ions and then to validate the quantitative method. The DQ method was extended to imaging by introducing a 2D-selective gradient echo imaging scheme.

RESULTS/DISCUSSION

In different resins, the Na^+ concentrations estimated for SQ and DQ spectrum are in good agreement with the expected ones. 2D DQ imaging localizes bounded Na^+ ions which are not observable using current SQ MRI (Fig. 1).

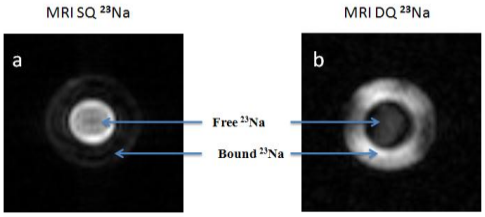

Figure 1: SQ and DQ 23Na images obtained in two concentric tubes containing bound (resin) and free sodium (solution).

On the background of these results obtained in model systems, DQ methods are now appropriate for quantifying and localizing bounded Na^+ ions in transformed foods. This method paves the way for studying the repartition of Na^+ in these foods and the impact of its binding state on sensory characteristics.

Mouaddab et al., Journal of Magnetic Resonance 189 (2007) 151–155