Utility of Long-TE *In-Vivo* MRS for Aspects of Fat Quantification with the Triglyceride Glycerol CH_2 Resonance

Clara J. Fallone[1], Logan Fairgrieve-Park[1], Atiyah Yahya[1,2]

1. Department of Oncology, University of Alberta, Edmonton, AB, Canada

2. Department of Medical Physics, Cross Cancer Institute, Edmonton, AB, Canada

Introduction

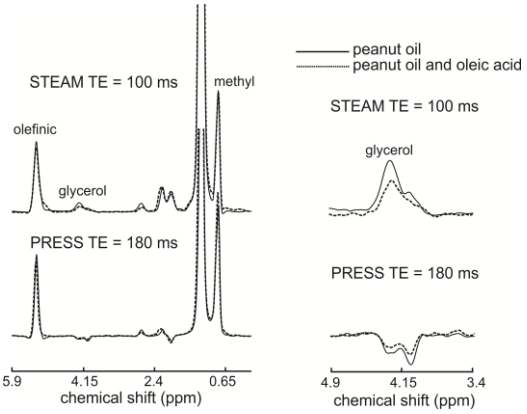
Changes in the triglyceride glycerol CH_2 protons (4.0-4.5 ppm) have been measured with MRS in osteoporosis; however, overlapping water signal rendered accurate glycerol quantification challenging[1]. It has been demonstrated that optimized long-TE PRESS (TE=180ms) and STEAM (TE=100ms) MRS techniques retain sufficient glycerol signal while resulting in significant water decay by T_2 relaxation[2]. Limited research has been performed on the glycerol CH_2 protons with *in-vivo* MRS. The purpose of the presented work is to demonstrate, in edible oils at 3T, that the long TE techniques enable relative levels of fat unsaturation to be determined through olefinic (≈5.4 ppm) to glycerol CH_2 ratios and that glycerol to methyl (≈0.9 ppm) ratios can potentially provide relative levels of triglyceride to free fatty acid content, a measure reported to be relevant to liver disease[3].

Methods

Experiments were performed with a 3T Philips MRI scanner and a birdcage head coil with long-TE PRESS (TE=180ms) and STEAM (TE=100ms, mixing time=20ms) using 32 averages, 3s repetition time, 2048 samples and 2000 Hz spectral width. Spectra were obtained from nine oils (peanut, almond, sesame, sunflower, corn, cod liver, canola, linseed, and walnut oil) at 3T and also with high resolution 16.5T NMR. In addition, long-TE spectra were measured from two vials, one containing triglyceride peanut oil, and the other containing an equal mixture of peanut oil and free fatty acid oleic acid. The expected glycerol CH_2 to methyl ratio for peanut oil is 4/9 while that for the peanut oil/oleic acid mixture is 0.22 (taking into account differences in densities and molecular weights). Therefore, the expected glycerol/methyl ratio of the mixed phantom relative to that of peanut oil is 0.5.

Results

Olefinic/glycerol ratios obtained with the long TE techniques were plotted against high resolution NMR ratios; ratios correlated with relative levels of unsaturation of the oils (R^2=0.79 for PRESS and R^2=0.90 for STEAM). Spectra obtained from the peanut oil and peanut oil/oleic acid vials are shown in the figure. PRESS and STEAM resulted in a glycerol CH_2 to methyl ratio of the peanut oil/oleic acid mixture to that of peanut oil of 0.63 and 0.55, respectively.



Discussion

Olefinic/glycerol ratios correlated with relative levels of oil unsaturation with R^2 values similar to those previously obtained for olefinic to methyl ratios[4]. Both PRESS and STEAM detect a drop in glycerol signal when free fatty acid oleic acid is mixed with the peanut oil. The relative glycerol/methyl ratios (mixed phantom ratio to peanut phantom ratio) measured with STEAM matches more closely with the expected value of 0.5, perhaps because of higher glycerol SNR obtained with it (relatively shorter TE).

Conclusion

Olefinic/glycerol ratios provide an estimate of relative levels of fat unsaturation (relevant to the study of cancer, obesity, osteoporosis and liver disease). In addition, relative amounts of triglycerides and free fatty acids can potentially be estimated by glycerol/methyl ratios (relevant to liver disease).

References

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