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EASTERN TIME [GMT-4]

Apparent Transverse Relaxation Times of ω-3 and non-ω-3 Fat Methyl Protons in Mouse Adipose Tissue at 9.4 T

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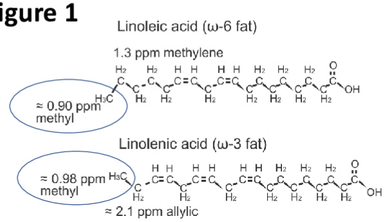
INTRODUCTION

- Omega-3 (ω-3) dietary fat intake is reflected in adipose tissue fat composition [1].
- Magnetic Resonance Spectroscopy (MRS) has been used to measure fat composition *in vivo*.
- Omega-3 fats have the the first carbon-to- carbon double bond on the third carbon from the end-chain fatty acid methyl, CH_3 (Figure 1).

Figure 1



Differences between ω-3 and non-ω-3 fats. The ω-3 methyl protons (≈ 0.98ppm) have a higher chemical shift than the non-ω-3 methyl protons (≈ 0.9ppm). They are adjacent to the 2.1 ppm allylic methylene protons, whereas non-ω-3 methyl protons border the 1.3 ppm methylene protons [2,3].

- Fat composition studies usually neglect ω-3 fats [4,5] because of their low concentration [6] and because the ω-3 methyl resonance cannot be separated from the non-ω-3 resonance with standard short-echo time (TE) *in-vivo* MRS techniques.
- Including ω-3 fat content in fat composition measurements is relevant because studies have revealed that their levels are altered in disease [7,8], correlate with bone health [9], and change with diet [1, 10-12].
- Previous research has separated the ω-3 resonance from that of the non-ω-3 peak by using a longer TE [13-15].

AIM

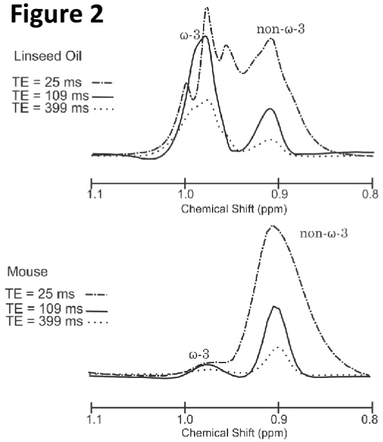
- To determine if differences exist between apparent transverse relaxation (T_2) times of ω-3 and non ω-3 fat methyl protons that could affect their relative quantification with magnetic resonance spectroscopy (MRS) at 9.4 T.

METHOD

- Spectra were acquired with a Point RESolved Spectroscopy Sequence (PRESS) MRS pulse sequence using TE values where the ω-3 and non-ω-3 methyl resonances are resolved.
  - These timings occur for TE values of $\frac{(2n+1)}{4J}$, where n is an integer. Assuming a coupling constant of 6.9Hz [16] yields a TE of 36 ms when n = 0, a TE of 109ms when n = 1, and so forth.
- PRESS spectra were acquired from 4 oils of varying ω-3 fat content (10 to 57 %) using TE values of 109 ms (TE_1 = 15 ms, TE_2 = 94 ms) and 399 ms (TE_1= 15 ms, TE_2 = 384 ms) to determine the apparent T_2 time.
- Spectra were also acquired with short TE (TE_1 = 15 ms, TE_2 = 10 ms) to illustrate that the ω-3 and non-ω-3 peaks are not resolved with short TE.
- Gated PRESS spectra were also acquired from abdominal adipose tissue of two mice fed a high ω-3 fat diet for 6 months.
- Peak areas of the ω-3 and non-ω-3 resonances were fit to a mono-exponentially decaying function in MATLAB to estimate an apparent (includes J-coupling effects) T_2 relaxation time for the ω-3 and non-ω-3 methyl protons for the oils and mice.

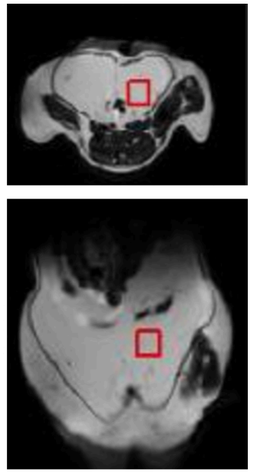
RESULTS

Figure 2



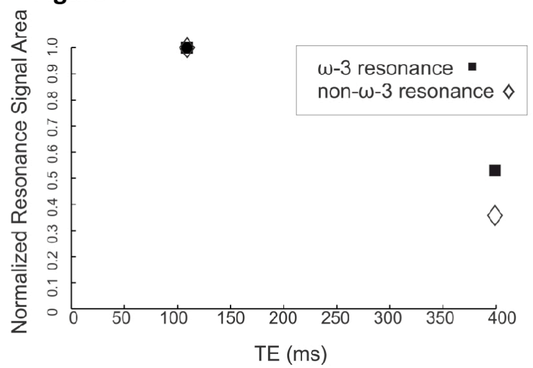
Linseed oil and mice spectra acquired with a short TE, a TE of 109 ms and a TE of 399 ms. The latter two TE values resolve the ω-3 and non-ω-3 methyl resonances.

Figure 3



Voxel localization in the visceral adipose tissue of a mouse.

Figure 4



Normalized ω-3 and non-ω-3 resonance signals for a mouse. The signals are normalized to the respective ω-3 and non-ω-3 resonance signals acquired with a TE of 109 ms.

- **In oils, average apparent T_2 relaxation rates were 906 ms and 414 ms for ω-3 and non-ω-3 methyl protons, respectively. Apparent T_2 relaxation times were on average 436 ms and 252 ms for ω-3 and non ω-3 methyl protons in mice, respectively.**

CONCLUSIONS

The ω-3 methyl proton T_2 relaxation time is higher than that of the non ω-3 methyl protons at 9.4 T and should be accounted for when estimating their relative amounts from long TE spectra.

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