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NMR is Science



An Extra Cheesy Resolution Phantom: A Yummy MRI Case Study of Formaggi Italiani

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Introduction



Figure 1: Surface view of cheesy resolution phantom acquired using an optical imaging modality.

Results

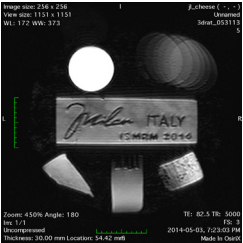


Figure 4: Coronal view of cheesy resolution phantom acquired using a 2D T1-weighted FSE sequence: FOV 48 cm², TR 5 s, TE 82.5 ms, ETL 16, NEX 2. Note the circular distribution of parmigiano-reggiano.

Applications

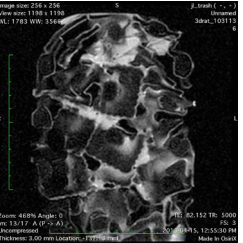


Figure 7: Cheese-stuffed ravioli with tomato sauce and T₁ weighting (FOV 18 cm², TR 5 s, TE 62.2 ms, NEX 2, ETL 16) imaged at 3.0 T.

Methods

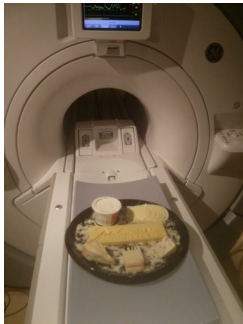


Figure 3: Cheesy resolution phantom was inserted supine into a GE MR750 3.0 T clinical scanner equipped with 50 mT/m gradients (200 mT/m slew rate) and 8 mW RF amplifier. Respiratory and cardiac gating did not greatly improve image quality. The study was carried out in accordance with an institutionally approved ethics protocol.

Acknowledgements

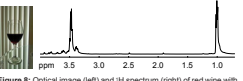


Figure 8: Optical image (left) and ¹H spectrum (right) of red wine with 20% D₂O (Agilent Inova 11.7 T, 13 μ s pulse, BW 10 kHz, 40k points). A customary accompaniment for the enjoyment of this study.

Figure 2: Geographical distribution of participants in multi-site study of Italian cheesy goodness. Asterisk indicates local Milanese origin.



Cheese	Fat/Water Ratio	Measured % Moisture	Theoretical % Moisture
Ricotta	0.05	73	73
Provolone	0.53	40	45
Mozzarella	0.39	32	42
Gorgonzola	0.60	28	40
Asiago	0.52	29	38
Parmigiano-Reggiano	1.86	17	33
Grana Padano	0.65	23	32

Table 1: Summary of cheesy properties. A syringe containing 5 mL of water was used for signal to % content normalization. Theoretical % moisture values were obtained from manufacturer product labels.

Figure 6: Whole body ¹H spectrum of provolone acquired at 3.0 T (500 μ s pulse, nominal flip angle 90°, BW 5 kHz, 2048 points). Peak integrals were used for quantitative analysis, summarized in Table 1.

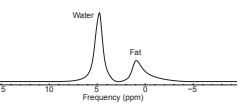


Figure 5: Reconstructed IDEAL water (top) and fat (bottom) coronal images of cheesy phantom (FOV 38 cm², BW 62.5 kHz, TR 215 ms, TE 12.9 ms, ETL 2, NEX 2, matrix 384x256) acquired using a GE MR450w 1.5 T clinical scanner. The nominal in-plane resolution was 1.5 mm x 1.0 mm. Note imperfect fat-water separation of the Grana.



A platter of fine Italian cheeses

Justin Lau, 2014
Medical Biophysics Department | University of Toronto

Field strength: 128 MHz

Why is this your favorite spectrum?

In the cheesiest study ever conducted on our 3.0 T clinical MR scanner, we performed proton spectroscopy and T2-weighted imaging on a collection of fine Italian cheeses. A representative spectrum of provolone is shown in Figure 6. Spectral peaks from water and fat were integrated to compute the fat and moisture contents of each cheese, as summarized in Table 1. The measured moisture content of ricotta agreed exactly with theory (according to the dairy product label). The other cheeses, however, were a bit on the dry side. A bonus spectrum of pinot noir, a customary accompaniment for the enjoyment of this study, is included in Figure 8. In the end, this was a very yummy experiment!

Initially presented at the 2014 ISMRM conference in Milan as a cheesy resolution phantom, we have since realized that a platter of fine Italian cheeses also makes an excellent educational phantom for teaching the idea of chemical shift and for practicing the art of fat-water separation.