

Advances in MRI of extracellular matrix of meat

J.M. Bonny, L. Foucat, M. Mouaddab, L. Sifre-Maunier, A. Listrat, J.P. Renou

QuaPA/STIM, INRA-Theix, St-Genès Champanelle, 63122, France

bonny@clermont.inra.fr

MRI is of great interest for the non destructive analysis of extracellular matrix (ECM) i.e. the intramuscular connective tissue. The general aim is to obtain information on both the spatial distribution and the composition (i.e. lipid, collagens, elastin) of ECM in muscle. These properties are implicated in food science for understanding the inherent biological factors that determine the textural properties of both meat and fish flesh. In meat, toughness is the main problem, while in fish, splitting of the flesh is the main issue.

Up to now MRI of ECM has laid little attention – except for imaging intramuscular fat which can be highlighted at high field using dedicated water-suppression MR sequences based on a hybrid T_1 and chemical shift contrast or on the difference between diffusion coefficients (1).

We previously proposed to image unfatty part of ECM on the basis of susceptibility difference between “hard” tissues and myofiber bulk matrix (2). If this finding has been confirmed also in isolated rat heart (3), an important issue is now to understand the role of the different ECM compounds on susceptibility effects. For this purpose, images obtained by MRI and immuno-histology were acquired on the same samples. The comparison underlines the dominant effect of elastin for provoking signal losses on susceptibility-weighted images due T_2^* shortening. Furthermore we develop complementary imaging technique, based on a double quantum filtering, able to detect signal coming from protons that experience anisotropic motion due to their interactions with ordered tissues of the ECM (4).

Lastly images depicting the ECM of meat need to be processed for extracting quantitative parameters related to muscle organization i.e. perimysium distribution and distribution of the fascicle size delimited by the perimysium. The main drawback comes from the ECM volume which is small compared to the one of the myofibers. Hence, even sensitive to ECM, images of muscle are characterized by a unique mode on their grey level histogram. Because most of current segmentation approaches fail in this context, quantitative analysis of ECM distribution requires specific techniques. An approach based on probabilistic reference maps was developed allowing an automatic identification of ECM in images (5). The results of this image processing chain were applied to correlate the size of muscle fascicles with mechanical properties of meat (6).

References:

- (1) Bonny and Renou, 7th ICAMRFS (2004) Copenhagen
- (2) Bonny et al, J. Sci. Food Agric. (2001) 81, pp 337-341
- (3) Köhler et al, Magn. Reson. Med. (2003) 49, pp 371-375
- (4) Mouaddab et al, GERM conference (2006) Blankenberge
- (5) Sifre-Maunier et al, Image Vision Computing (2006) in press
- (6) Sifre et al, J. Agric. Food Chem (2005) 53, pp 8390-8399