Investigation of the fate of different fat emulsion meals in the Gastro-intestinal using MRI and MRS
Mahmoud Omar Hussein 1, Luca Marciani, Caroline L. Hoad 1, Mary Stephenson 1, Eleanor F Cox 1, Elisa Placidi 1, Susan Pritchard 1, Carolyn Costigan 1, Henelyta Ribeiro 1, Elisabeta Cianpi 1, Pip Rayment 1, Asish Nandi 1, Nick Hedges 1, Paul Sanderson 1, Harry Peters F Peters 1, Robin C. Spiller 1, and Penny A. Gowland 1

1. The Sir Peter Mansfield Magnetic Resonance Centre, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom, 2. Nottingham Digestive Diseases Centre and NIHR Biomedical Research Unit, University of Nottingham, Nottingham, United Kingdom, 3. Colworth Science Park, Unilever Discover, Sharnbrook, Unilever Discover, Vlaardingen, Netherlands

Background: The relationship between meal structure and composition, and the way the meal is handled by the body and the resulting sense of satiety are critical to understanding how to control and reverse the rising tide of obesity. MRI can monitor gastrointestinal (GI) function 1,2, including the spatial and temporal distribution of fat and water in the stomach separately3,4,5, and these parameters can be related to hormonal responses and the sense of satiety 6. This work aims to determine the effect of emulsion microstructure on the handling of fat by the GI tract, using model fat emulsion meals and MRI and MRS to monitor the response of the GI tract. Since emulsions with larger mean droplet size will usually cream in the acidic gastric environment, Locust Bean Gum (LBG) was used to control the emulsion stability. Objective: To determine how emulsion stability and droplet size modulate GI handling of fat emulsions.

Methods: Meal preparation: Three emulsion meals were prepared: CONTROL coarse unstable emulsion (mean droplet diameter ~8 µm), COARSE stable emulsion (mean droplet diameter ~7 µm) and a FINE stable emulsion (mean droplet diameter ~0.4 µm). The CONTROL meal contained 79% water, 20% sunflower oil, 1% Tween20 emulsifier, sweetener and flavouring. For COARSE and FINE meals the water was replaced by 0.6% LBG solution. Emulsions were blended at 13,500 rpm: CONTROL for 20 min, FINE and COARSE for 5 min. FINE emulsion was then passed through a high pressure Microfluidizer. Subjects: The study was approved by the local Ethics Committee. 11 healthy male volunteers aged 18-35 years with no history of GI disease attended on 3 mornings each having fasted overnight. Initial baseline scans were acquired and then the volunteer was given 300g of a meal (60g fat in total) in random order. Scanning was performed hourly for 5 hours. Scanning: Abdominal scans were acquired using a Philips 1.5T Achieva MR scanner and SENSE-body coil in ~15 min: 40 transverse slices acquired in two 13s breath-holds, flip angle=80°, TR/TE=2.8/1.4ms, FOV=400mm, in plane resolution 1.56x1.56mm, SL=7mm, SENSE 2.0. Proton spectroscopy to determine intragastric fat distribution: STEAM (90°x90°x90°), TR=4s, TE=9ms, 2 dummies, resolution=25x25x25mm, spectra bandwidth 1000 Hz, 512 samples, 4 repeats in 24 s; 2 VOIs acquired separately in the upper and lower regions of the gastric lumen corresponding to different components of the gastric contents due to layering in the supine position were identified on the bT1FSE images. The areas of the water and fat peaks were measured using in-house software, and lipid/water ratios were calculated. To measure Small Bowel Water Content (SBWC): 24 coronal FSE images in a single breathhold, in-plane resolution =1.56x1.56mm, SL=7mm, with no gap between slices. Data were analysed with in-house software 1.

Results: Fig 1 shows differences in gastric emptying curves (overall p = 0.006; FINE vs CONTROL p<0.01). Fig 2 shows a typical bT1FSE image, spectrum and variation of fat content in different regions of the stomach with time, and demonstrates layering of the CONTROL emulsion, but not of the other meals. Fig 3 shows SBWC images and volume time course. The FINE emulsion significantly reduced the amount of an ad libitum pasta meal eaten after the experiment compared to COARSE ( p<0.05) and also compared to CONTROL(p<0.001).