Gastric coagulation and postprandial amino acid absorption of milk is affected by mineral composition: a randomized crossover trial

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Background

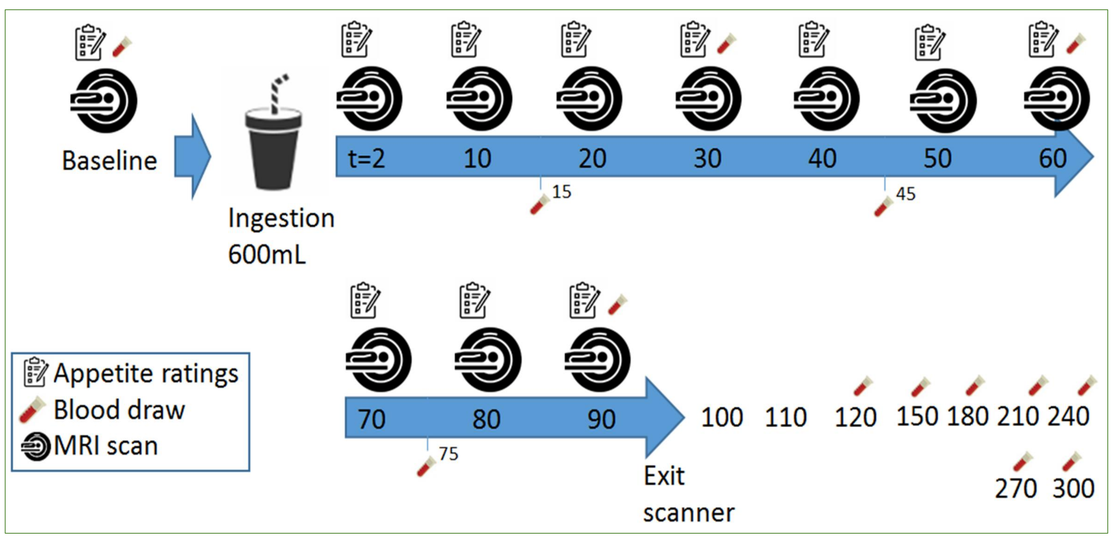
In vitro studies suggest that casein coagulation of milk is influenced by its mineral composition. The degree of casein coagulation in the stomach may affect the dynamics of gastric protein digestion, stomach emptying and appearance of amino acids (AA) in the blood, but this needs to be confirmed *in vivo*.

Objective

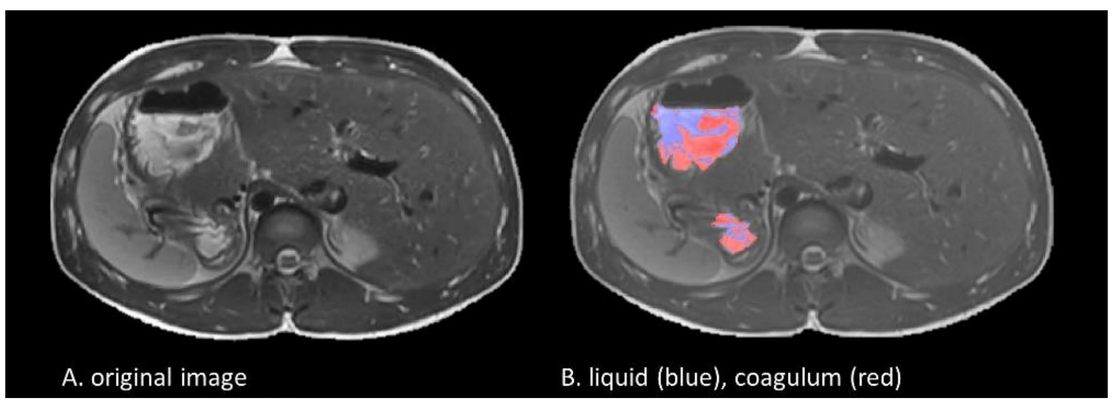
This study aimed to compare gastrointestinal digestion between two milks with the same total calcium content but different casein mineralization (CM).

Methods

- Fifteen males (age 30.9±13.8 y, BMI 22.5±2.2 kg/m2) participated in this randomized cross-over study with two treatments.
- Participants underwent gastric magnetic resonance imaging (MRI) scans at baseline and every 10 min up to 90 min after consumption of 600 ml of milk with low or high casein mineralization.
- Blood samples were taken at baseline and up to 5 hours postprandially to determine AA concentrations.
- Primary outcomes were postprandial plasma AA concentrations and gastric emptying rate.
- Secondary outcomes were postprandial glucose and insulin levels, gastric coagulation and other product instabilities, if detectable, and appetite ratings obtained after each MRI measurement.
- Gastric content was categorized as liquid or solid using intensity thresholding with Otsu's method. Four image texture metrics were calculated for the segmented stomach contents using the LIFEx software[1]



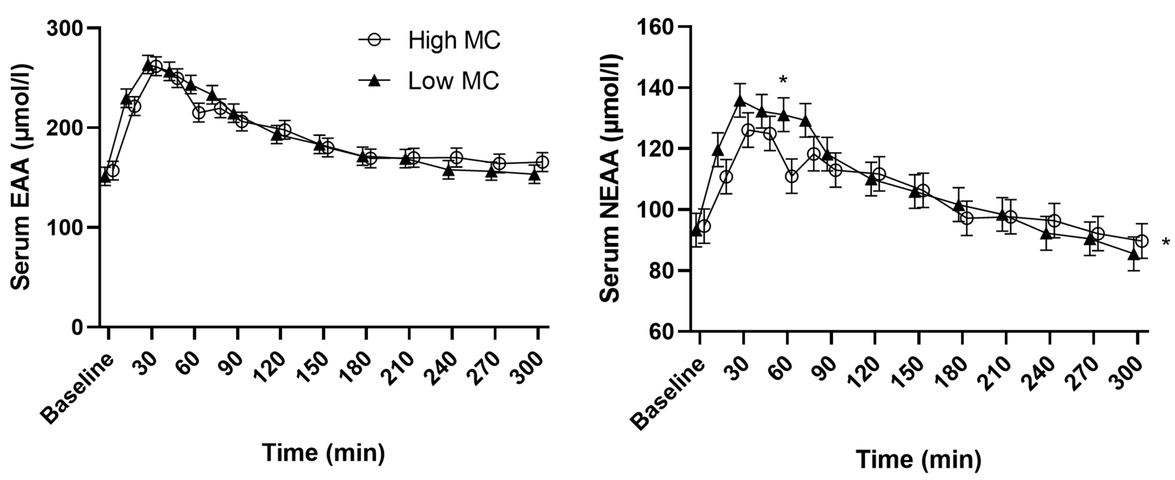
Overview of a test session



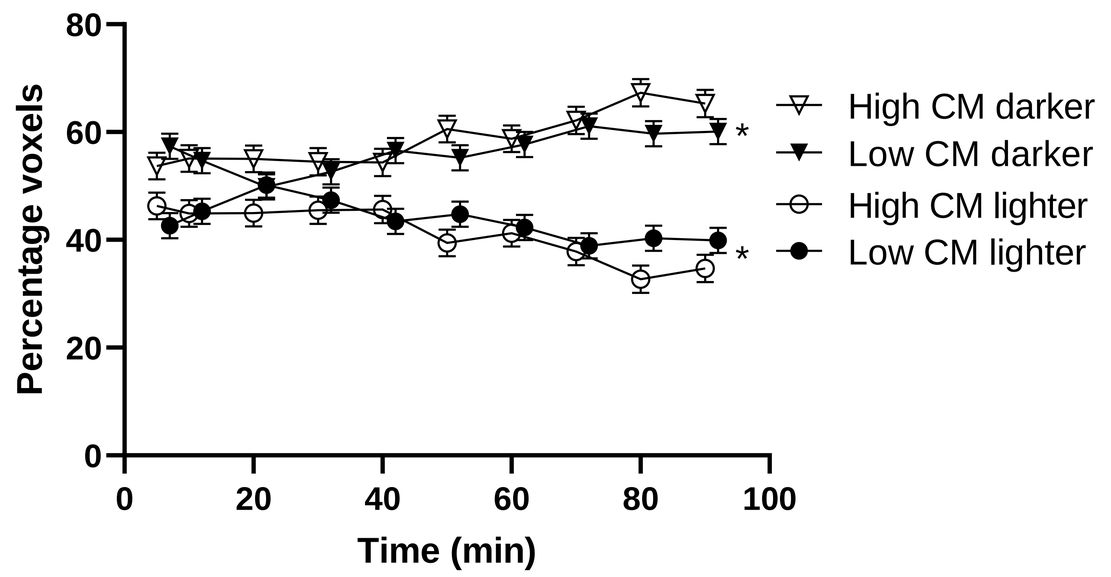
*A. T_2-weighted axial MRI image showing a cross-sections through the stomach 60 min after 600 ml skimmed milk consumption. The darker stomach content is coagulation. B. Image with stomach contants categorized into lighter, more liquid voxels as **blue**, and darker, more solid voxels as **red** using Otsu's thresholding method.*

Results

- Gastric content volume over time was similar for both treatments. However, gastric content image analysis suggested that the liquid fraction (lighter) emptied quicker in the high CM milk, while the coagulum (darker) emptied slower.
- Relative to high CM, low CM showed earlier appearance of AAs that are more dominant in casein, such as proline (MD 4.18 µmol/L, 95 % CI [2.38-5.98], p<0.001), while there was no difference in appearance of AAs that are more dominant in whey protein, such as leucine.
- The image texture metrics homogeneity and busyness differed significantly between treatments (MD 0.007, 95% CI [0.001, 0.012], p=0.022; MD 0.005, 95% CI [0.001, 0.010], p=0.012) potentially because of a reduced coagulation in the low CM milk.



Mean ± SEM of serum essential amino acid (left) and non-essential amino acid (right) concentrations after high and low CM milk ingestion. *p < 0.05 placed above the value denotes a significant time point, at the right of the graph it denotes a significant treatment effect.



Mean ± SEM percentage of two intensity categories of voxels of stomach content (lighter (more liquid) and darker (more solid)) after applying the thresholding method. *Denotes a significant difference between treatments (n=15).

Conclusions

Casein mineralization of milk can influence gastric coagulation and postprandial serum AA kinetics. This knowledge may help to determine the optimal processing of dairy products and their effect on digestion and health.

Acknowledgements

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1. Nioche, C., et al., LIFEx: A Freeware for Radiomic Feature Calculation in Multimodality Imaging to Accelerate Advances in the Characterization of Tumor Heterogeneity. Cancer Res, 2018. 78(16): p. 4786-4789..