In vitro digestion simulation of medium chain fatty acids (MCFA) using static and dynamic protocols

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Introduction

Medium-chain fatty acids (MCFAs) are fatty acids with 6-12 carbons in the chain length. They are supposed to go through a preferential absorption and metabolic route in the stomach, passing into the portal vein to the liver to be rapidly metabolized (Mumme and Stonehouse, 2015). During decades they have been used as a special energy source within a variety of clinical nutrition settings. The medium-chain triglyceride (MCT) oil is a product specially tailored to contain high amounts of MCFAs. MCT oils are produced by hydrolysis of coconut oil, filtration of MCFAs, and subsequent re-esterification. To perform its best, the MCT oil lipolysis has to occur, majorly, in the gastric phase. In this work, the dynamic gastrointestinal (GI) model system, developed at the University of Minho (Pinheiro et al., 2016), and an international harmonized static *in vitro* digestion protocol were applied to investigate the gastrointestinal digestion of MCT oil samples and their free fatty acids (FFAs) release profiles.

Experimental section

Material

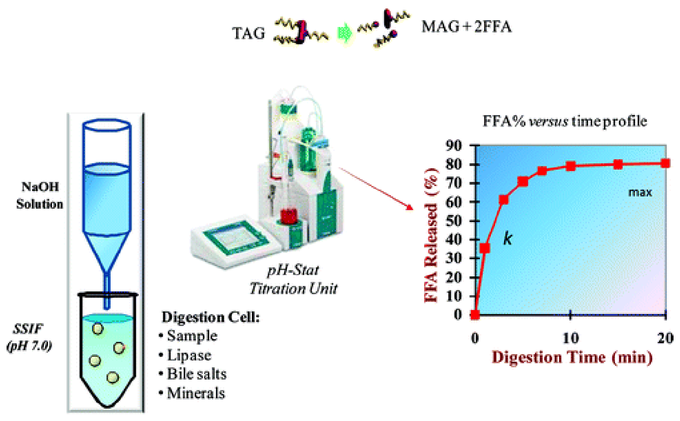
- Medium Chain Triglyceride (MCT) oil (KFD Nutrition, Warszawa, Poland)

MCT oil total fatty acid composition

Fatty acid	MCT oil % m/m
Caproic acid (C6)	0.09
Caprylic acid (C8)	49.22
Capric acid (C10)	50.66
Lauric acid (C12)	-
Mirystic acid (C14)	0.02
Palmitic acid (C16)	-
Palmitoleic acid (C16:1)	-
Stearic acid (C18)	-
Oleic aicd (C18:1)	-

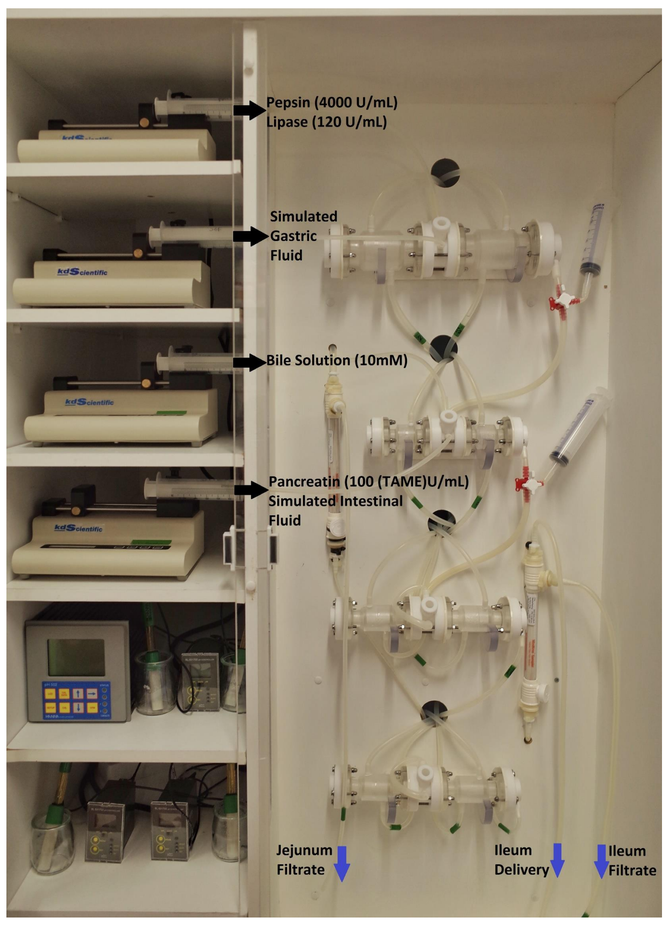
Methods

pH-stat *in vitro* digestion model



Li, Y. and McClements, D.J. (2010)

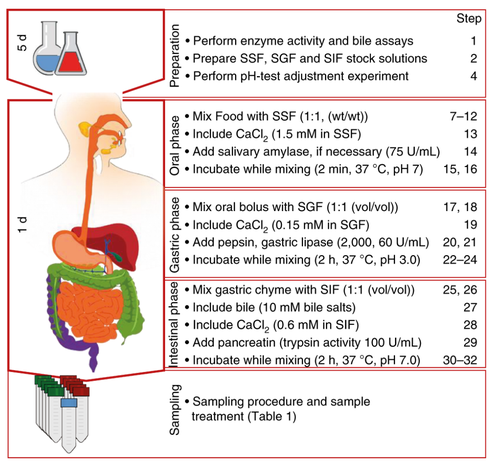
Dynamic *in vitro* GI model



Dynamic gastrointestinal *in vitro* digestion model, comprising the simulation of stomach, duodenum, jejunum and ileum.

Static *in vitro* digestion protocol

- International consensus INFOGEST



Brodkorb, A. et al. (2019)

Dynamic *in vitro* digestion protocol

Standardized static (Brodkorb et al., 2019) and semi-dynamic (Muleto-Cabero et al., 2020) international consensus

Gastric compartment
- *MCT oil feed*
- *SGF Mix*
- *Enzymes RGE + pepsin*
- *Gastric emptying (89 min)*
- *Sampling (at min 22, 56, and 89)*

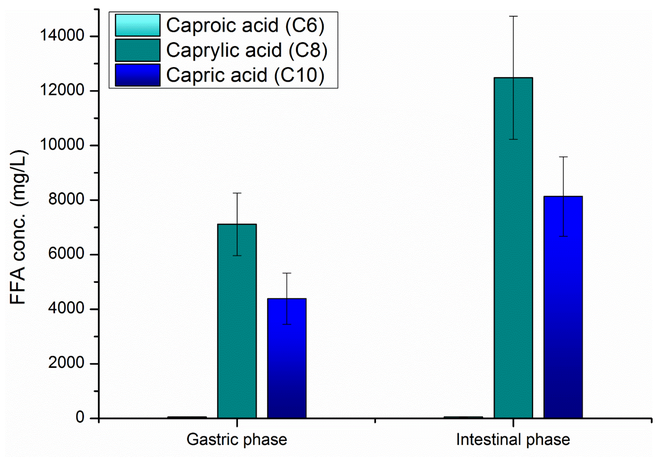
Duodenal compartment
- *Gastric aliquots feed*
- *SIF Mix + pancreatin*
- *Bile salts*
- *Sampling (at min 33, 67, and 101)*
- *Compartment emptying (101 min)*

Jejunal compartment
- *Duodenal aliquots feed*
- *Outlet connected to membrane system 1*
- *Compartment emptying (~= 120 min)*
- *Sampling (filtrated samples)*

Ileal compartment
- *Jejunal non filtrated aliquots feed*
- *Outlet connected to membrane system 2*
- *Compartment emptying (~= 150 min)*
- *Sampling (filtrated and non filtrated samples)*

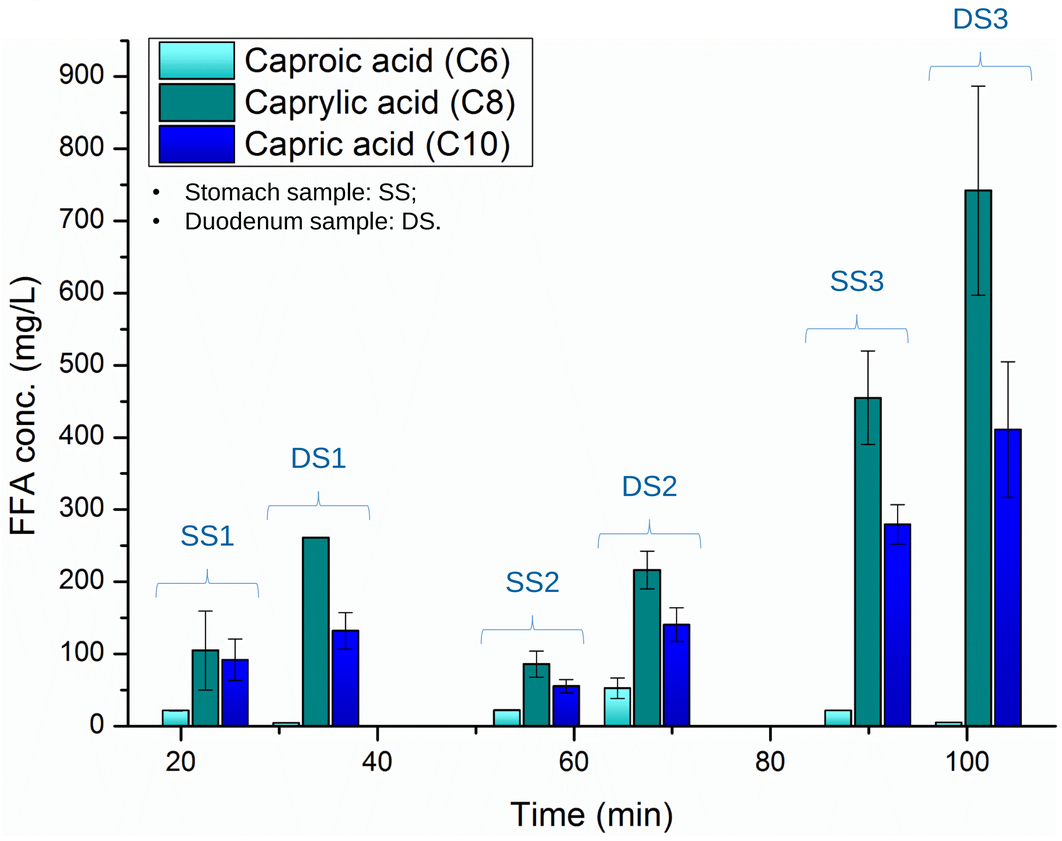
On average, only 56.90% of MCFAs were released during stomach digestion simulation

Static *in vitro* digestion FFA profile



- Samples' FFA profiles obtained with gas chromatography (GC) analyses;
- 55.84% and 57.96% of free MCFAs released at the gastric phase in static and dynamic protocols, respectively;
- FFA concentrations of samples taken from the static protocol are higher than dynamic protocol's.

Dynamic *in vitro* digestion FFA profile



Conclusions

This study employed the static and dynamic *in vitro* digestion protocols to investigate the MCFAs lipolysis rates and the profile of FFA released during subsequent GI tract digestion phases. Because *in vitro* dynamic assays are designed to represent more realistic GI tract conditions, one may notice that this protocol resulted in smaller gastric lipase efficiency, leading to smaller FFA concentrations and lipolysis rates. When comparing digestion phases lipolysis rates, it is worth to mention that the observed gastric lipolysis rates are higher than those expected to occur in this phase for natural oils, particularly, because of the high concentration of MCFAs in MCT oil.

Acknowledgments

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