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Studying the real-time interplay between triglyceride digestion and lipophilic micronutrient bioaccessibility using droplet microfluidics. 1 Lab on a chip method

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1 **Studying the real-time interplay between triglyceride digestion and lipophilic**
2 **micronutrient bioaccessibility using droplet microfluidics. 1 Lab on a chip method**

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6 **Abstract**

7 This article is the first part of a series reporting on real-time digestion kinetics of triglyceride
8 droplets containing different lipophilic micronutrients. This part focuses on the design,
9 fabrication, and operation of a polydimethylsiloxane microfluidic device which enables the
10 generation and digestion of oil droplets. The micro-channels were made hydrophilic to obtain
11 oil droplets in an aqueous continuous phase. Optimized chip design and outlet control were
12 implemented to provide efficient oil droplet generation, manipulation, and immobilization on a
13 single chip. Highly monodisperse oil droplets were generated, immobilized in an array of
14 traps and monitored in real time by fluorescence using a confocal microscopy method. The
15 device was used to study the kinetics of beta-carotene release during tricaprylin digestion
16 (intestinal lipolysis and micellar solubilization). The effect of the gastric phase on beta-
17 carotene degradation was also investigated using the same method.

18

19 **1. Introduction**

20 Over the past decades, the development of technologies based on microfluidics has
21 expanded in analysis and research domains (Huebner et al., 2009; Šalić, Tušek, & Zelić,
22 2012). Indeed, the use of micro-scale experimental devices involves small sample volumes
23 with a high surface-volume ratio that allows reduction of costs and rapid kinetics study. In
24 addition, the optical transmission of the materials commonly used in microfluidics (mostly
25 polydimethylsiloxane (PDMS), poly(methyl methacrylate) (PMMA), and glass) provides high
26 flexibility to use external light-based analysis techniques for real-time monitoring (Desai &
27 Zaman, 2015; Heus et al., 2010; Mongersun, Smeenk, Pratx, Asuri, & Abbyad, 2016;
28 Windbergs & Weitz, 2011). With the trend of further reducing the sample volume, droplet
29 microfluidics was developed. In this technique, each droplet is used as an independent
30 micro-reactor of pico- to nano- litre scale (Huebner et al., 2009; Huebner, Abell, Huck,
31 Baroud, & Hollfelder, 2011; Mongersun et al., 2016). However, most of the studies are based

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