Modelling the breakdown mechanics of solid foods during gastric digestion

Krista C. Drechsler, Maria J. Ferrua

PII: S0963-9969(16)30064-3
DOI: doi: 10.1016/j.foodres.2016.02.019
Reference: FRIN 6190

To appear in: *Food Research International*

Received date: 11 August 2015
Revised date: 23 February 2016
Accepted date: 26 February 2016

Please cite this article as: Drechsler, K.C. & Ferrua, M.J., Modelling the breakdown mechanics of solid foods during gastric digestion, *Food Research International* (2016), doi: 10.1016/j.foodres.2016.02.019

Modelling the breakdown mechanics of solid foods during gastric digestion

Krista C. Drechsler[aI] and Maria J. Ferrua[aII]

[a]Riddet Institute, Massey University. Private Bag 11 222, Palmerston North 4442, New Zealand.

Abstract.

Solid food disintegration within the stomach has a major role on the rate and final bioavailability of nutrients within the body. Understanding the link between food material properties and their behaviour during gastric digestion is key to the design of novel structures with enhanced functionalities. However, despite extensive research, the establishment of proper relationships has proved difficult. This work builds on the hypothesis that to bridge this knowledge gap a better understanding of the underlying mechanisms of food disintegration during digestion is needed. The purpose of this study is to propose a new protocol that, by uncoupling the physicochemical processes occurring during gastric digestion, allows for a more rigorous understanding of these mechanisms. Using steamed potatoes as a product model, this study aims to develop a viable methodology to characterize the role of gastric juice and compressive forces on the breakdown mechanics of solid foods during digestion. From a general viewpoint, this work not only reveals the importance of the parameter used to describe the size distribution of the particles on the interpretation of their breakdown behaviour, but also provides a new framework to characterize the mechanisms involved. Results also illustrates that food breakdown during gastric digestion might well not follow a unimodal behaviour, highlighting the need to characterize their performance based on parameters describing broad aspects of their particle size distribution rather than single point values. Arguably simplistic on its approach, this study illustrates how an improved understanding of the role of chemical and physical processes on the breakdown mechanics of solid foods can facilitate valid inferences with respect to their *in-vivo* performance during digestion. In particular, it shows that while the contraction forces occurring in the stomach can easily disintegrate the potato matrix into fine particles, the continuous exposure to gastric juices will promote their disintegration into progressively smaller debris. A discussion on the challenges and future directions for the development of a more general and standardized implementation of this protocol is provided. Not intended to reproduce the breakdown behaviour of foods during gastric digestion, but rather to characterize the mechanisms involved, the proposed protocol would open new opportunities to identify the material properties governing the performance of different foods upon ingestion.

Keywords. Gastric digestion, Food material properties, Breakdown mechanics, Solid foods.

1 Introduction

The role of food structures on the nutritional and functional performance of foods during digestion is by now widely recognized in the area of food research (Parada and Aguilera, 2007; vanAken, 2010; McClements and Li, 2010; Turgeon and Rioux, 2011; Van Kleef et al., 2012; Nicolai and Durand, 2013; Norton et al., 2014).

Upon ingestion, foods undergo a number of physicochemical changes that lead to their disintegration, transport, and absorption into the body. While the result of a complex series of physicochemical processes occurring along the entire gastrointestinal tract, research has evidenced

[I]E-mail: kcdrechsler@gmail.com.
[II] Corresponding author: E-mail: m.j.ferrua@massey.ac.nz. Phone: +64 6 256 9099 extn 84292.