Fast and slow food – a matter for digestion

Researchers at TEAGASC Moorepark are leading the way in studies of *in vitro* digestion models.

When we eat food, a vast number of chemical, biochemical and biological processes are initiated. Some of these are well understood, whereas others are a complicated interplay of chemical reactions and physiological responses within the body. The first steps in the digestion of food involve the oral (mouth), gastric (stomach) and intestinal phases, where the food disintegrates into its nutrients in a form that can be absorbed by the body. To understand the physiological response to specific foods, it is necessary to follow these complex digestive processes within the human digestive tract in more detail. However, *in vivo* human intervention trials to correlate diet with the health of different demographic groups can be difficult to undertake, unsuitable, expensive, or may be unjustifiable on ethical grounds. For these reasons, *in vitro* models have been developed to simulate the digestion of food in the laboratory.

In vitro digestion models

Teagasc researchers at the Moorepark Food Research Centre have been to the forefront in developing and internationally standardising digestion models. These lab-based models, called *in vitro* models, can be simple static 'one-pot' methods such as the INFOGEST method,[1,2] or more sophisticated semi-dynamic methods.[3] Some of the more recently developed methods can also recreate the diverse physiological conditions of specific population groups such as infants, adults, older adults and those with compromised digestive systems. *In vitro* digestion studies assess changes in the structure of food during gastrointestinal (GI) transit, as well as the bioavailability of digested food.

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Slow and fast digestion

Carbohydrates are commonly classified as slow and fast molecules because their structure can affect the rate of absorption as well as the metabolic and hormonal response to a meal, as measured by the well-established glycaemic index. Equally, proteins fall into two categories – fast and slow – based on their amino acid absorption.

For instance, caseins from milk and most plant proteins such as those from soy, pea, nuts or seeds are known as slow proteins, whereas whey proteins are typically referred to as fast proteins. Key factors in determining the rate of protein digestion are their structure during gastric digestion and the rate of gastric emptying, i.e., how fast the food can transfer from the stomach into the small intestine.

The importance of gastric digestion studies

Controlling the gastric digestion using different food structures can be a tool for delivering specific rates of nutrients to the digestive tract. Food tailored to the specific digestive requirements of particular population groups can be of great benefit, e.g., faster nutrient digestion will benefit athletes for a quick recovery after exercise. On the other hand, slowing gastric

emptying could help to enhance the effect of satiety, i.e., the feeling of 'fullness' after eating, and thus delay the onset of hunger in healthy and overweight people, but also in those with diabetes, by reducing or delaying the peaks of glycaemia or lipaemia. Controlling gastric emptying can also improve digestive complications such as gastric reflux and aspiration pneumonia in infants and older adults.

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Moorepark's role in the development of our understanding of gastric digestion

The components of food and how they are processed in particular can have a profound effect on how they are digested. For example, the heating of milk can eliminate dangerous pathogenic organisms and preserve it for weeks or even months. Brodkorb and co-workers have used *in vitro* digestion to show that ultra high temperature (UHT) processing milk leads to softer curd formation in the stomach in comparison to that of raw and pasteurised milk.[4]

This implies that low-heat milk is digested more slowly than high-heat milk, a result that was confirmed by some preliminary testing on humans using wireless endoscopy. The differences in the gastric behaviour were named 'gastric re-structuring', as this better describes how food with identical nutrients and ingredients can be digested differently.

Corrigan and Brodkorb[5] recently observed that milk protein products intended for infant formula can be digested differently depending on the prior processing. Pre-digestion, or hydrolysis, of the milk proteins provided a head start in the gastric digestion when compared to the non-hydrolysed, intact protein products. A lower observable protein coagulation or curd formation was found in the gastric phase of casein-dominant formulas, which could lead to an earlier onset of gastric emptying in infants. This could help with the design of infant formula, lowering gastrointestinal transit times. This might help ease problems associated with their digestion, particularly for infants where breastfeeding was not an option.

Continuous improvements in digestion models

Currently there is a lack of reliable physiological data on the digestion mechanism of infants. Moorepark researchers are currently leading an observational human study, InfantDigest, in collaboration with Trinity College Dublin, Children's Health Ireland Hospital Crumlin, University College Cork and Cork University Maternity Hospital, funded under an Enterprise Ireland Innovative Partnership Programme with industry partners. The collection of this *in vivo* information will help to prepare more accurate and robust *in vitro* methods to simulate the immature digestion of pre- and full-term infants.

Industry impact

Teagasc researchers perform *in vitro* and *in vivo* digestion studies for the manufacturers of foods, food ingredients, supplements and infant formula, both on a collaborative project and straight client contract basis. The findings of these projects can help start-ups, small, medium and multinational companies to better position their products in the marketplace and help substantiate claims regarding the digestive behaviour of food or food ingredients.

Acknowledgement

This work was funded by Enterprise Ireland Innovative Partnership Programme (No. IP20160515 – InfantDigest), the Department of Agriculture, Food and the Marine, COST action INFOGEST FA1005, and Dairy Research Ireland (project "ProPart").

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