

## Plenary 4: Gut Physiology: Gut Function and Nutrition

### Non-invasive tests for the evidence-based assessment of functional foods

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**Background** – Interest in the functionality of foods has been increasing in the last decade. The development of new foods with functional components now requires an evidence-based approach to ensure their efficacy from a preventative and treatment perspective. It will become mandatory to demonstrate that foods, both natural and those produced by new processes can modify diseases and disorders affecting the gastrointestinal system. Whilst proof of concept is an important process in the pathway to describing new functionality using animal models, the ultimate challenge is to provide and design human studies that fulfill the public health needs and regulatory requirements. Non-invasive testing systems will play an important role in this strategy.

**Objective** – To demonstrate the use of a range of novel non-invasive tests showing efficacy in both animal models of disease and gut damage, and their subsequent use in human studies. The importance of gut function determined non-invasively to understanding absorption of nutrients, micronutrients and bioactives within foodstuffs will also be shown. The motility of the gut plays a role in the efficiency of absorption as does the status of health of the epithelial layer and its barrier function capacity. Irritable bowel syndrome affects a high proportion of the developed world, between 15-25% at any one time. We have shown that this is characterized by an altered gastric emptying of both liquid and solid foods and it is also likely that a subset of these individuals have a low-grade inflammation in the intestine. A pipeline from animal models to human studies will be described.

**Design** – The development pipeline uses these non-invasive tests in animal models as proof of concept before proceeding to human trials. Different foods and components of foods can be tested in this setting to decide whether human studies should be undertaken.

**Outcomes** – Studies in altered motility that can affect food functionality and potentially micronutrient uptake will be described. Additionally the role that maturation of the small intestine might play during early development, in old age and when the intestine is damaged or diseased will also be highlighted (e.g. during chemotherapy for cancer). Examples of enteropathy in susceptible populations (e.g. indigenous children) show that this can compromise their growth and potentially also have an impact on the effectiveness of supplementation programs. A range of foods such as rice, wheat, corn and other staple crops grown with elevated levels of Fe, Zn and Vitamin A can now be rapidly tested in animal models and in human trials with respect to the absorptive capacity of individuals. The effects of cultural practices such as prior preparation of food and different cooking techniques can also be assessed mechanistically. For example the extent of effects of cooking or fermentation on resistant starch can be assessed in humans *in vivo* (1) and the role of particular probiotics or putative probiotics can be determined as proof of concept for modifying gut damage (2) and gut dysfunction in disorders such as atopic eczema.

**Conclusion** – The use of non-invasive tests in both animal models but more particularly in human studies, both population studies and clinical trials is now possible to describe the functional status of the gut. These new tests can be used for large cohorts of free living individuals and be collected remotely and transported without freezing or special conditions (e.g. sent in the post). They can also be used to validate bioavailability in different populations, both those that are healthy and those in settings where gut disease may be endemic. Information on mechanisms, particularly those induced by naturally-sourced bioactive agents and new formulations demonstrating therapeutic promise can be ascertained. Segmentation of populations with respect to their gut health can also now be achieved to improve the success rate and interpretation of nutritional studies.

#### References

1. EL Symonds, S Kritas, TI Omari, RN Butler. A combined  $^{13}\text{CO}_2/\text{H}_2$  breath test can be used to assess starch digestion and fermentation in humans. *J Nutr.* 134: 1193-1196 (2004).
2. KL Tooley, GS Howarth, GP Davidson and RN Butler. Oral ingestion of *Streptococcus thermophilus* diminishes severity of small intestinal mucositis in methotrexate treated rats. *Cancer Biol Therap.* 5(6): 593-600 (2006).