Concurrent Session 5: Functional Foods II

**Relative glycaemic impact of foods determined by in vitro digestive analysis of potentially glycaemic carbohydrate**

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**Background** – Relative glycaemic impact (RGI) is defined as glycaemic carbohydrate yield from digestion of a food intake, expressed as glycaemic glucose equivalents (GGE), that is, as the weight of glucose required to induce the same glycaemic response as the specified food quantity. It is a food property theoretically measurable in vitro to describe the relative glycaemic potency of foods.

**Aims** – To develop a method for in vitro digestive determination of relative glycaemic impact, and to establish the relationship between the GGE content of foods measured by the method, and by in vivo blood glucose responses.

**Design** – A method was developed to measure soluble sugar release from food carbohydrates during simulated gastric (pepsin-HCl) and then ileal (pancreatin/amylloglucosidase) digestion of foods, and used to measure the GGE content of 83 foods in 11 food groups. Glycaemic responses to the same foods were measured in human volunteers to allow comparison of in vivo and in vitro GGE values by linear regression and Bland-Altman methods analysis.

**Outcomes** – *In vitro* GGE values predicted *in vivo* GGE values for five of the food groups: breads (\(R^2 = 0.59, \ P<0.001\)), crackers/cakes/bars (\(R^2 = 0.77, \ P = 0.001\)), snack foods (\(R^2 = 0.93, \ P <0.001\)), fruits (\(R^2 = 0.79, \ P <0.001\)), and vegetables (\(R^2 = 0.60, \ P <0.001\)). The relationship was not significant for breakfast cereals, “sundry cereals”, dairy-based foods and combination foods. The in vitro method had far greater precision than the clinical method, but a Bland-Altman analysis showed a consistent bias, with the in vitro method over-predicting *in vivo* GGE as GGE intake increased, in all food groups except breads.

**Conclusion** – *In vitro* digestive analysis has potential to provide an economical measure of the glycaemic potency of foods, but more research on modulators of glycaemic response is required to allow adjustment factors to be built into equations relating *in vitro* and *in vivo* determinations of glycaemic impact. Then, high precision, state-independent *in vitro* values for RGI may be more useful than low precision, state-dependent *in vivo* values.

**Glycaemic carbohydrates: standardisation of in vitro methods**

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**Background** – *In vivo* methods for determining GI are slow, costly and hence unsuitable for routine analysis (e.g. for food product development purposes). An array of *in vitro* methods for the glycaemic analysis of foods currently exists, including our own high throughput *in vitro* method which is a precise and validated predictor of glycaemic response to carbohydrate-based foods.

**Objective** – To quantify effects of differing conditions used by various *in vitro* carbohydrate digestion methods on the results they provide, in order to develop a robust, standardised method capable of economically measuring the glycaemic potency of foods with accuracy and precision.

**Design** – Relative effects of *in vitro* methodological variables on the rate and pattern of sugar release from five food types were measured. Variables included mode of food comminution, method of stirring, digestive enzyme concentrations and combinations, as well as pH, temperature and duration of enzyme incubations. The standard test foods used were wheat grains, lasagne, chick peas and potato, all boiled, and white bread.

**Outcomes** – Measurements of rapidly and slowly digestible, and resistant starch for the five foods differed depending on the mode of sample comminution, particularly for wheat and pasta. Pancreatin retained a high digestive capacity across a range of concentrations (0.001% - 2%), pH values (4 – 7), and beyond the duration (2 h) used to determine slowly digested starch, based on its capacity to digest additional substrate. An amylloglucosidase digestion needed to be used in conjunction with pancreatin but could be included as a secondary digestion of digesta aliquots.

**Conclusions** – Early work demonstrates that variation between methods can introduce significant differences in the in estimates of glycaemic potency that they yield. Hence, a thorough investigation of the parameters defining different steps in the determination of glycaemic potency by *in vitro* digestion is warranted before a robust and standardised method is decided on.