

Invited commentary

Could glycaemic index be the basis of simple nutritional recommendations?

Nowadays, obesity and diabetes are increasing at high speed, becoming a major health problem which requires nutritional recommendations. It is widely accepted that a lack of physical activity and an excessive energy content of the diet play a role in this development (Prentice & Jebb, 1995). On the other hand, the relative responsibility of the type of nutrients, i.e. carbohydrate *v.* fat, has been disputed (Willett & Stampfer, 2003). As part of this debate the precise nature of the nutrient has also been questioned. For fat, the superiority of MUFA has been emphasised whereas for carbohydrate it is still largely debated. Digestible carbohydrates can be categorised according to its biochemical structure as a simple sugar (mono- or disaccharide) or as complex sugars (mostly starch). However, from a physiological point of view, it is more relevant to refer to carbohydrate biodisponibility than to structure. Carbohydrate biodisponibility is not only due to the biochemical structure, but is also dependent on the nature of the sugar and the matrix of food. For health purposes it seems better to choose carbohydrates inducing a weak glycaemic and insulinaemic response than a high one.

The glycaemic index (GI) has been developed to obtain a numeric physiological classification of carbohydrate foods based on the rate of carbohydrate absorption in order to improve nutritional advice (Jenkins *et al.* 1981). For the GI measurement, glycaemia is measured at fasting and during 2 or 3 h following the ingestion of the test food. The glycaemic response is compared with that of the same amount of carbohydrate from a reference food. The methodology of the determination of GI has been discussed by numerous authors (size of the carbohydrate load, 25 or 50 g; reference product, glucose *v.* white bread; time of follow-up, 2 or 3 h, etc) and different ways of calculation have been proposed (Wolever, 2004). If recommendations are to be given using GI, a consensus on the methodology should be obtained at the international level.

Beside these methodological problems, the GI of food is highly variable. This index is dependent on numerous factors. These are: the nature of the carbohydrate food (sugar or starch); the type of sugars (fructose, saccharose, lactose, etc); the status of starch (gelatinised or retrograded); the matrix of food (fibres, protein–starch interaction in durum wheat, the amylose:amylopectin ratio, the particle size and food form); the anti-nutrients (enzyme inhibitors, lectins, tannins) (Jenkins *et al.* 2002). All this makes the classification of carbohydrate foods by the GI rather complex. Recently, Foster-Powell *et al.* (2002) has published a wide compilation of data. It clearly shows that for an important number of foods, there is a

great variability in the GI, dependent on the origin of the food and the way of cooking (time, temperature, water content, etc).

The insulin response is also important from a physiological point of view and some have proposed the use of the insulinaemic index (II) as a complement of the GI (Bornet *et al.* 1987). It is generally accepted that there is a good correlation between II and GI (Holt *et al.* 1997) but it is not always the case (Ostman *et al.* 2001) as also shown in the paper from Flint *et al.* (2004) in this issue of the *British Journal of Nutrition*.

Moreover, carbohydrate foods are seldom eaten alone, but rather as part of a mixed meal. Then much more complex phenomena occur, related to the addition of fat and protein which will modify the gastric emptying and the insulin secretion; and thus the GI and II. In their paper ‘The use of glycaemic index tables to predict glycaemic index of composite breakfast meals’ Flint *et al.* (2004) compared predicted *v.* measured GI and II of mixed breakfasts in a group of healthy volunteers. Their results show that calculating GI from tables does not allow the actual GI of a mixed meal to be predicted. Furthermore, GI and II were not correlated with each other. The study is very well designed, and the results clearly indicate that the calculation of GI using tables is not appropriate. This is one of the first studies that demonstrates this, and hence it conveys an important message. In addition to their major observation, the authors provide additional correlation analysis which tends to demonstrate that fat and energy content are a predictor of GI. These conclusions could be debated as the authors used a univariate analysis, whereas protein, fat, energy and carbohydrate are not independent variables, and a multivariate model should have been used. In fact, there was no need to model the effect of fat and protein since it is already known that these factors modulate glucose metabolism.

There is a need for a simple index that could help in nutritional recommendations. It appears that GI could not be the only criterion to choose healthy food as it is largely modulated by other variables, especially by the other components of a mixed meal. Before making recommendations for choosing low-GI food, we need to have studies showing the effect of low-GI *v.* high-GI food in conditions where the energy content and the macronutrient partition are constant. Studies have tested the impact of a low-GI *v.* a high-GI regimen in different pathological situations. A low-GI diet appears to have a beneficial effect on blood glucose control in diabetics (Brand-Miller *et al.* 2003). However, studies on healthy subjects testing the effect of low-GI regimens without changes in other parameters are still

lacking and are absolutely required before expanding the GI concept in our nutritional recommendations.

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