IUNS 20th International Congress of Nutrition
GRANADA (SPAIN), SEPTEMBER 15-20, 2013
"Joining Cultures Through Nutrition"

GLYCEMIC RESPONSE OF CEREAL PRODUCTS IS MAINLY EXPLAINED BY ITS SLOWLY DIGESTIBLE STARCH, FAT AND FIBRE CONTENT

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Background and Objectives:

The concept of glycemic Index developed in 1981 by Jenkins *et al*. allows to describe the variations in physiological responses produced by different carbohydrate-containing foods. Cereal products exhibit a wide range of glycemic response. Several studies in the past have shown that physico-chemical characteristics of the products, as protein and fat contents can influence glycemic index of food products. As well, the rate and extent of starch digestibility modulate the glycemic response induced by the intake of food products. The aim of the present analysis was to determine which parameters within the nutritional composition and starch digestibility can explain the most Glycemic Index (GI) and response parameters.

Methods:

An internal database including nutritional composition, starch digestibility and glycemic responses, including GI of 190 cereal products have been used for this analysis. The influence of the different nutritional composition and starch digestibility parameters on the GI has been evaluated by Partial-Least Squares. For nutritional composition, protein, fat, total dietary fibers, fructose, Free Sugar Glucose (FSG) and available carbohydrates have been considered in the initial analyses. For starch digestibility parameters, Slowly Digestible Starch (SDS) and Rapidly Digestible Starch (RDS) have been tested. In addition to GI, several other parameters have been included in these models : the incremental Area Under the Curve (iAUC), the maximum concentration (Cmax) and the difference between Cmax and baseline value (deta peak) for glycemia.

Results:

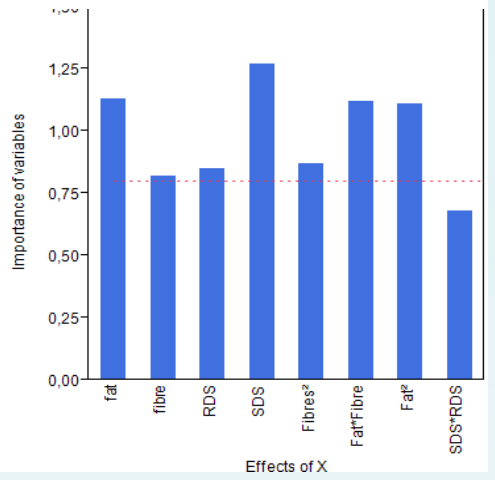
The database used for these analyses contained data for 190 cereal-based food products. They can be classified into 4 main categories : extruded cereals (n=23), dried bakery products and crackers (n=23), soft bakery products (n=9) and biscuits (n=135) including rotary molded biscuits (n=70). We performed a Partial-Least Square (PLS) analysis testing at the same time Glycemic Index (GI), Cmax, delta peak and iAUC for glycemia and integrating all the nutritional and starch digestibility parameters. From this analysis, 4 parameters appeared to have significant influence on parameters of glucose responses : RDS, SDS, fat and total dietary fibers.

We incorporated in the model all the interactions between the different parameters. We selected those with a VIP (Variable Importance for the Projection) > 0.8 and a contribution > 5%. Here, SDS, fat, fibers, RDS and the interactions fat², fibers², fat x fibers and SDS x RDS appeared to have significant influence.

This model, including the 4 glycemic response parameters, explains 49% of the responses, with SDS, fat and fibers appearing as the main factors influencing these responses. Considering the glycemic index and responses separately, this model explains:

- 53 % of glycemic index
- 41 % of iAUC of glycemia
- 41 % of Cmax glycemia
- 60 % of delta peak glycemia.

Figure 1 : Graphic of importance of variables



In figure 2, for a same range of fat and fibers, GI appears to be higher in the lowest SDS cluster and to be reduced across two others. Moreover, GI decreases with increased fiber content. Fat seems also to reduce the GI, but in a lower extent.

Figure 2 : Impact of fiber and fat contents on GI in 3 SDS clusters

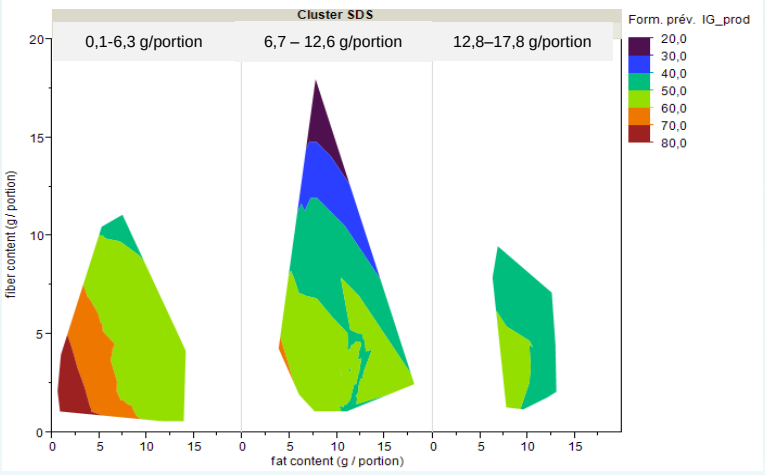
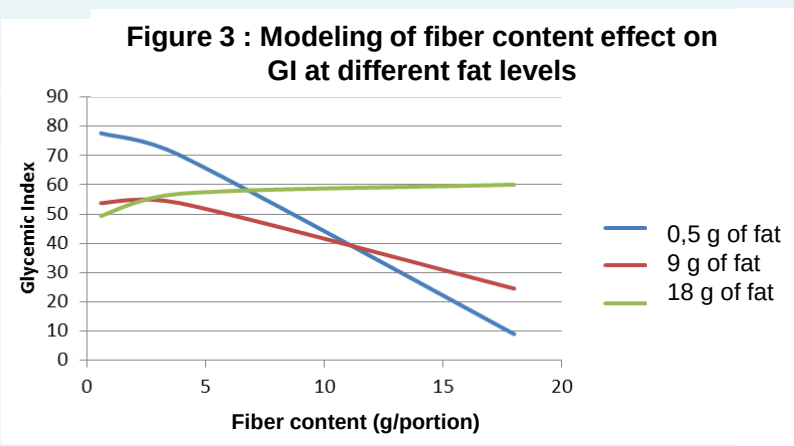


Figure 3 : Modeling of fiber content effect on GI at different fat levels



To better understand the specific effect of fiber, fat and their interaction, we modeled the effect of SDS, fat and fibers on the different glycemic parameters. As an example on figure 3, increasing fiber content strongly decrease GI response. This effect is however reduced when increasing the fat content of products. These effects are consistent with the 3 other glycemic parameters.

Conclusions:

These analyses, performed on a database including 190 cereal-based food products made with different technologies and presenting different nutritional compositions, confirm previously published data that SDS, fat, fiber and RDS contents in the cereal products are the main parameters explaining glycemic responses induced by these products. Glycemic Index is well linked with these parameters, but the delta peak of glycemia appears also as a relevant parameter reflecting the nutritional composition of these products, with 60% explained by these nutritional and starch digestibility factors.
In a technological prospective, starch digestibility appears as an important parameter to consider in addition to nutritional composition parameters in order to develop cereal products leading to reduced glycemic response without disproportionally increased insulin response as this has been recognized as a relevant benefit in a metabolic health perspective.

Keywords:

Glycemic Index, cereal foods, starch digestibility, nutritional composition

Poster Reference Number : PO2938