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What's the science behind glycemic response?

The growing interest in glycemic response in the food & beverage industry

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A Leatherhead Food Research white paper

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What's the science behind glycemic response?

Sustained energy release and glycemic response have become a focus for the food and beverage industry, as consumers call for healthier products. In this white paper, Aida Sainz explains the nuances between glycemic response, glycemic index (GI) and glycemic load, discusses the regulatory framework and considers the future for low GI products carrying health claims.

During the last few years there has been an increased concern about sugar consumption. The Scientific Advisory Committee on Nutrition (SACN) now recommends decreasing the intake of free sugars to 5% of daily energy requirements, because of the increased risk of weight gain, obesity and dental health problems occasioned by the consumption of too much sugar.

Reducing the amount of sugar in products readily available to the consumer is a major challenge for the food industry. Furthermore, simply decreasing sugar might not be the whole story. Leatherhead advises that organisations look more holistically at the issue and develop healthier products with a lower glycemic response (GR), glycemic index (GI) and glycemic load (GL).

What are GR, GI and GL?

The glycemic response (GR) to a food or meal is the effect that it has on blood glucose levels after consumption.

Glycemic index (GI) was first coined as a term around 30 years ago by Jenkins *et al.* GI is a quantitative assessment of foods based on blood glucose response after eating expressed as a percentage of the response to an equivalent carbohydrate portion of a reference food[1].

Different carbohydrate-containing foods provoke different glycemic responses depending on the following factors[2,3]:

- Type of carbohydrate
- The proportion and type of sugars and starch
- The starch structures
- The particle size
- Fibre content
- Presence of nutrients that increase insulin secretion (i.e. protein, specific amino acids and fat)
- Method of preparation
- Acidity

[1] Augustin L.S. *et al*. (2002) Glycemic Index In chronic disease: a review. *European Journal of Clinical Nutrition*, **56**:1049-107.
[2] Inga Schneider *et al.* (2015) Comparison of Glycemic Index and Satiety of Cereals containing Amaranth. *Journal of Human Nutrition & Food Science,* **3(5)**: 1074.
[3] Augustin L.S*. et al.* (2015) Glycemic index, glycemic load and glycemic response: An International Scientific Consensus Summit from the International Carbohydrate Quality Consortium (ICQC). *Nutr Metab Cardiovasc Dis*, **25(9)**:795-815.

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The GI system classifies carbohydrates according to how fast they raise glucose levels in the blood:

- **High GI foods**: GI value ≥ 70. These products are characterised by a fast release of carbohydrate and result in higher blood glucose levels, providing a quick source of energy
- **Medium GI foods**: GI value in between 56-69
- **Low GI foods**: GI value ≤ 55. Foods with a lower GI value produce a slow carbohydrate release and a more gradual increase of blood glucose over a given time

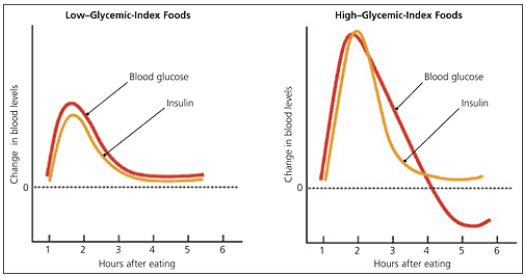

Fig. 1: Graph showing the blood glucose and insulin response of low and high GI foods

Foods that elicit a high rise in plasma glucose also stimulate a rapid rise in blood insulin, termed insulinaemia (as shown in figure 1 above). Repeated bouts of hyperglycaemia and hyperinsulinaemia may result in insulin resistance or transient hypoglycaemia due to the rapid rise and fall of the blood glucose levels. It has been suggested that this reactive hypoglycaemia can stimulate the appetite and lead to increased caloric intake. Furthermore, insulin resistance will develop into type 2 diabetes and it increases the risk of developing metabolic syndrome.

The glycemic load (GL) is a measure that takes into account both the amount of carbohydrate present in a portion and the GI. It can be applied to individual foods, meals and diets. GL can be calculated with the following formula:

GL food = GL food x total amount of available carbohydrate (g in the food portion/100).

Why measure the GR, GI and GL of foods?

There has been substantial scientific evidence supporting the fact that food products with a low GI, GL and reduced glycemic and insulinemic responses can have beneficial physiological effects.

Low GI/GL diets help to reduce total body fat mass, the risk of type 2 diabetes, coronary heart diseases by improving insulin sensitivity, blood lipids (i.e. LDL cholesterol) and inflammatory markers. In addition, they may also influence many physiological processes relevant to physical and cognitive performance and appetite regulation[3].

Due to these reasons the measurement of the GR, GI and GL can be beneficial for companies that:

- Are planning to reformulate or create healthier products
- Produce products for the sport industry
- Produce food products for people in hospitals or other institutions who have special medical requirements, for example people suffering from cardiovascular diseases, diabetes or obesity

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GI limitations

Nowadays there are a few concerns with respect to GI:

- GI does not vary in response to the amount of food consumed, whereas GR does. A selection of products based on their GI can work properly only when the products compared contain the same amount of available carbohydrate. For example, pasta can have a lower GI than melon but per portion pasta has more carbohydrates than melon. Therefore, if you eat similar amounts of pasta and melon, the former would have a higher impact on your blood glucose levels. For this reason, the GL might be more useful.

- Not all low GI foods are a healthier option. An exclusive focus on GI for food selection could lead to food choices that are inconsistent with the dietary recommendations. For example, a food product can have a low GI value and have a high content of fat, therefore it is not recommended to consume it on a daily basis.

Health claims

For a business to be able to advertise the nutritional or otherwise benefits of their products, they would need to make a visible claim. Regulation 1924/2006 defines a "claim" as any message or representation, which is not mandatory under community or national legislation. It includes pictorial, graphic or symbolic representation, in any form, which states, suggests or implies that a food has particular characteristics[4].

Types of Claims

There are two types of claims:

1. **Health claims**
2. **Nutrition claims**

1. A **health claim** is any statement about a relationship between food and health. There are different health claims and they are based on scientific evidence. The European Food Safety Authority (EFSA) is responsible for evaluating the scientific evidence supporting health claims and covers the following:
    a. 'Function Health Claims' (or Article 13 claims)
        i. Relating to the growth, development and functions of the body
        ii. Referring to psychological and behavioural functions
        iii. Weight-control
    b. 'Risk Reduction Claims' (or Article 14(1)(a) claims) on reducing a risk factor in the development of a disease
        i. For example: "Plant stanol esters have been shown to reduce blood cholesterol. Blood cholesterol is a risk factor in the development of coronary heart disease".

[4] Regulation (EC) No. 1924/2006 of the European Parliament and of the Council on nutrition and health claims made on foods, as amended (Official Journal of the European Union L12, 18.1.2007, 3-17)

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c. Health 'Claims referring to children's development' (Article 14(1)(b) claims)
    i. For example: “Vitamin D is needed for the normal growth and development of bone in children”[5].

2. A **nutrition claim**[6] is any claim which states, suggests or implies that a food has particular beneficial nutritional properties due to:
    a. The energy (calorific value) it:
        i. Provides
        ii. Provides at a reduced or increased rate or
        iii. Does not provide
    b. The nutrients or other substances it:
        i. Contains
        ii. Contains in reduced or increased proportions or
        iii. Does not contain

Could it be possible to make a claim for low GI products?

As glucose is the main source of energy for the body and the only one for the brain, a low GI product could be defined as a product able to slowly release energy to the body. As mentioned above, it also decreases the risk of developing chronic diseases.

Worldwide, GI has been used on labels in different countries in recent years. The regulatory status of GI is not uniform across jurisdictions:

- EFSA concluded in 2010 that carbohydrate foods with a low GI were not sufficiently characterised, and hence a cause-effect relationship could not be established between low GI food products and their claimed effects. However, the list of EU authorised health claims does include some for ingredients that have been found to reduce post-prandial glycemic responses, such as “Consumption of pectins with a meal contributes to the reduction of the blood glucose rise after that meal”. Therefore, EFSA recognises the capacity of foods and ingredients which reduce post-prandial blood glucose response to have a beneficial effect if the IR is not disproportionally increased.
- The Food and Drug Administration in the United States has no official opinion, so there is no impediment to use GI, however food manufacturers are compelled to provide accurate and not misleading information in line with the regulations.
- The Canadian Food Inspection Agency and Health Canada established that statements related to the GI were not acceptable.
- Australia and New Zealand have provisions for GI claims, regulated by the Australian New Zealand Food Standards

[5] Commission Regulation (EC) No. 983/2009 of 21 October 2009 on the authorisation and refusal of authorisation of certain health claims made on food and referring to the reduction of disease risk and to children’s development and health (Official Journal of the European Union L277, 22.10.2009, 3-12)
[6] Nutrition claims are only permitted if they are listed in the Annex of Regulation (EC) No 1924/2006, lastly amended by Regulation (EU) No 1047/2012

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Code; through Food Standard 1.2.7 and Schedule 4[7].

- South Africa currently has draft legislation on GI claims under R429, though this has not yet been passed into law.

Conclusions

Despite its history, at the moment GI is a novel concept from a regulatory point of view and the problems explained above need to be addressed to translate GI knowledge into practice successfully. One suggestion would be to introduce nutritional criteria (a controlled energy content, total and saturated fat content and protein content for example) for any food bearing a GI claim. Foods should also be tested by a laboratory which follows an appropriate standardised method. Although a full regulatory structure is still to be finalised, there is sufficient evidence in the field that suggests that variations to GI, such as GL, will provide useful nutrition information to consumers in the future.

As testament to this, many Leatherhead members are developing food & beverage products which they want to test for both GI and glycemic response. We offer an expert service measuring GI, GL, glycemic response and insulin response to foods and beverages. For more information, please contact Aida Sainz: aida.sainz@leatherheadfood.com, 01372 821584.

[7] Elham Moghaddam *et al.* (2006) The Effects of Fat and Protein on Glycemic Responses in Nondiabetic Humans Vary with Waist Circumference, Fasting Plasma Insulin, and Dietary Fiber Intake. *J. Nutr,* 136(10):2506-2511.

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How Leatherhead can help

We offer consulting services in all areas relating to glycemic index, glycemic response and glycemic load. We offer expert analysis of a range of product matrices, and have assisted numerous companies in the successful completion of the product development process.

Key features of our service:

- Testing to the highest recognised standard (WHO/FAO 1998)
- Approved by an independent ethics committee
- High degree of accuracy using the latest in glucose-analysing equipment
- Additional testing can be carried out to include: available carbohydrate content and insulin response
- Efficient turnaround

Your GI results – for each product tested you can request:

- The exact methodology used
- GI values and rating (low, medium or high)
- Graphical interpretation of results

About the author

Aida Sainz, a senior scientist within Nutritional Research graduated in 2008 with a BSc in Nutrition and Dietetics from the University of Madrid (Universidad Autonoma) and obtained a second BSc in Food Science and Technology in 2011. In 2008 she started her MSc in Food Industry Management with a 6 month work placement with Nestlé, at Baby Food Application Group, where she worked in product development. Aida has also worked as a community nutritionist where she was in charge of nutrition and health of patients with a wide range of diet-related concerns, such as weight management, gastrointestinal problems, food allergy and intolerances. Her role at Leatherhead involves heading up the glycemic testing area and she has worked on a European funded project (iFAAM) related to food allergens and allergy management. Aida also works on a variety of laboratory and desk-based nutrition projects, including practical human nutrition intervention studies.

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Leatherhead Food Research provides expertise and support to the global food and drink sector with practical solutions that cover all stages of a product's life cycle from consumer insight, ingredient innovation and sensory testing to food safety consultancy and global regulatory advice. Leatherhead operates a membership programme which represents a who's who of the global food and drinks industry. Supporting all members and clients, large or small, Leatherhead provides consultancy and advice, as well as training, market news, published reports and bespoke projects. Alongside the Member support and project work, our world-renowned experts deliver cutting-edge research in areas that drive long term commercial benefit for the food and drink industry.

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