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Parameters controlling the glycaemic response to breads

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Bread is one of the most widely consumed staple foods worldwide. White-wheat bread, largely consumed in France, is made from highly refined flour, which leads to a low nutrient density. Due to a highly porous structure and gelatinised starch, it is easily broken down during digestion, leading to a rapid increase of glucose released into the bloodstream. Low glycaemic responses are considered favourable to health, especially against a background of diabetes. Literature reports show that selection of raw material is an essential factor in decreasing the glycaemic index (GI) of white bread. There are two means of decreasing the rate of starch degradation: either (i) slowing gastric emptying rate and/or glucose diffusion–absorption through the intestinal mucosa, which can be achieved by incorporating soluble fibre or organic acid in bread, or (ii) limiting starch accessibility to α-amylase by using high-amylose cereal varieties and/or incorporating intact cereal grains. Studies on cereal products show that preservation of the food structure during digestion seems to be a more important GI-reducing factor than the degree of starch crystallinity or the presence of soluble fibre. Thus, we should look to produce bread with a more compact food structure or higher density, which is the case in leavened wholewheat bread or bread with intact cereal grains. The baking process should also be improved to achieve this goal, by using, for example, a reduced kneading time or less yeast than usual.

Breads: Glycaemic index: Food structure

Introduction

Bread is consumed in various forms (white-wheat bread, brown bread, whole bread, bran-enriched bread, and multi-cereal bread, among others). In France, only 15 % of energy intake is derived from bread. An increase in bread consumption in low-bread-consuming countries would be a good way to readjust the carbohydrate:lipid ratio from 45:40 to 55:30 (% of energy), as is generally recommended. Not only the quantity consumed but also the nutritional quality of bread should be improved. Quality varies widely according to the raw materials and baking processes used.

For example, white-wheat bread is made of refined flour (type 55) impoverished in micronutrients (minerals, vitamins, trace elements, phytomicronutrients, fibre) and therefore having a low nutrient density. Moreover, white-wheat bread elicits a high glycaemic response (increase in plasma glucose concentrations after food intake), thereby increasing the risk of metabolic diseases such as type 2 diabetes, CVD and obesity.

However, the glycaemic response to bread varies widely according to the type of bread studied. The glycaemic index (GI; defined as the area under the blood glucose curve following ingestion of a test food, expressed as a percentage of the corresponding area following an equivalent load of a reference carbohydrate, either glucose or white-wheat bread) given in the Foster-Powell table for ninety-five types of bread (Foster-Powell *et al.* 2002) varies from 27 (barley bread with 75 % whole grains) to 95 (extremely porous French baguette). This extreme variability reflects very different rates of starch digestion; starch from a French baguette is rapidly digested, leading to a glycaemic response close to that of glucose (GI 100), whereas starch from bread containing intact cereal grains is digested more slowly. Both raw materials and baking processes can therefore influence glycaemic response.

Low to moderate GI (<70) are considered favourable to health, especially for the prevention of CVD, obesity and type 1 or 2 diabetes (Food and Agriculture Organization & World Health Organization, 1997). Hence, an understanding of the mechanisms underlying such high variability in glycaemic responses for bread appears to be of prime interest. However, in the *in vivo* studies published, the test foods are rarely well characterised, be it at molecular level (degree of starch gelatinisation and retrogradation, percentage of amylose), at microscopic level (starch interactions with

Abbreviation: GI, glycaemic index.

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