Glycemic index and glycemic load of commercial Italian foods

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Abstract (max 250 words)

Background and Aim: The glycemic index (GI) and glycemic load (GL) are useful parameters in the nutritional classification of carbohydrate foods. Diets characterized by a low GI and/or a low GL have been repeatedly and independently associated with decreased risk of diabetes and other chronic diseases. The aim of this study is to report the GI and GL value of carbohydrate-rich foods available on the Italian market and mostly consumed in Italy.

Methods and Results: GI values were determined according to FAO/WHO (1997) and ISO (2010). Overall, the 142 commercial foods that were analyzed represent food categories that are the source of >80% carbohydrate intake in Italy. The food items chosen were based mainly on the market share of the brand within each food category and grouped into 13 food categories: 1) beverages: fermented milk drink, juice, smoothie, soft drink; 2) biscuits; 3) breads; 4) bread substitutes; 5) breakfast cereals; 6) cakes and snacks; 7) candy and confectionery; 8) cereals; 9) desserts and ice-creams; 10) marmalade and jam; 11) pasta; 12) pizza; 13) sugar and sweetener.

Conclusion: This database of commercial Italian foods partly overcomes the lack of information on GI of local foods, contributing to a better understanding of the association between GI/GL and health and providing a more informed choice to Italian consumers and health practitioners.

Introduction

The glycemic index (GI) was developed to systematically classify foods according on their ability to raise postprandial glycemia [1]. Carbohydrates in foods with a low GI are more slowly digested and absorbed and, consequently, diets with a low GI are beneficial in controlling postprandial plasma glucose excursions [2]. Since the overall impact of one food on postprandial response is due to the combination of GI and the amount of carbohydrate in that food, an independent index has been proposed [3]. The glycaemic load (GL) is defined as the mathematical product of the grams of available carbohydrate in the food portion and the food's GI, divided by 100. The physiological validity of the GL concept as predictor of postprandial glycemia and insulin demand has been demonstrated for foods high in carbohydrate and low in fat and protein [4]. Subsequently, GL was standardized to the energy of the food portion consumed (GL/1000 kJ) for better representing carbohydrate-based foods combined with fat and protein [5]. The food GL standardized to energy results the single best predictor of the glycemic response of foods, taking into consideration not only the quantity of carbohydrates but also the presence of other nutrients [6].

In nutritional epidemiology the use of GI and/or GL, as a descriptor of diets and food patterns, is common. Diets low in GI and GL, but not in total carbohydrates, are associated to lower type 2 diabetes mellitus (T2DM) risk [7,8], cardio-vascular disease (CVD) risk [9,10], levels of pro-inflammatory markers and fasting insulin [2]. However, conflicting results have appeared in the literature, for example, the opposing conclusions of some studies on the risk of T2DM [11,12]. A major confounder for the validity of GI/GL data in epidemiological research is the use in local contexts of international GI/GL food databases, which may not correctly represent the actual products present on the local market. A second confounder is the limited number of foods or preparations mapped for GI/GL in an ever-growing food market.

Despite some doubts on the validity of the GI concept raised by recent guideline documents [13], the ability to control postprandial glycemia is considered to be extremely useful by most health institutions [14]. The European Food Safety Authority [15], the World Health Organization [16], the American Diabetes Association [17], the Diabetes UK [18], the Canadian Diabetes Association [19], the Italian Society of Human Nutrition [20] and the International Carbohydrate Quality Consortium [6] all provide qualified support for this concept.

In this context, there is need to communicate information on GI/GL to the general public and health professionals and to establish better and unbiased tools for nutritional research, with a focus on foods and preparations that are consumed locally. Therefore, the aim of the present study was to measure a sufficiently large and detailed set of GI/GL values of commercial foods commonly consumed in Italy in order to improve the quality of Italian nutritional databases.

Methods

All the analyses have been performed at the Department of Food Science (Nutrition Unit) of the University of Parma and at the Department of Food, Environmental and Nutritional Sciences (DeFENS) of the University of Milan over 10 year period between 2005 and 2015. The GI values were determined following the method described by the Food and Agriculture Organization/World Health Organization [16] and, later, applying the guidelines set up by the International Standards Organisation [21].

Subjects

Healthy subjects were recruited from the local communities during the last 10 years. All subjects met the inclusion criteria: non-smoking, aged 18–69 years, stable body weight, BMI of 19–25 kg/m^2, normal glucose tolerance, regular physical activity, normal dietary habits, no history of eating disorders, no gastrointestinal disorders, no diabetes, no medications known to affect glucose tolerance, no pregnancy, no breastfeeding, not intolerant or allergic to any of the foods. All the subjects of this study were previously informed on the details of the protocol, and about the risks involved in participation and they gave their written informed consent to participate to the study, according to the Helsinki declaration on human rights. The studies were case-by-case approved by the ethical committees of the University of Parma and of the University of Milan.

Foods

The 13 food categories investigated were: 1) beverages: fermented milk drink, juice, smoothie, soft drink; 2) biscuits; 3) breads; 4) bread substitutes; 5) breakfast cereals; 6) cakes and snacks; 7) candy and confectionery; 8) cereals; 9) desserts and ice-creams; 10) marmalade and jam; 11) pasta; 12) pizza; 13) sugar and sweeteners, representing the source of >80% of the carbohydrate intake in Northern Italy [22]. Food items were commercial products belonging to the above categories selected according to the market share of the producer within each category. In addition, specialty foods or different brands were also selected in order to expand the category surveyed. Each food was purchased in a single batch on the local market or directly obtained by the producer in sufficient amounts to provide the required number of food portions to the selected number of volunteers. Portion sizes were calculated according to manufacturers' nutrition information. All food items were portioned to provide either 50 g of available carbohydrate or 25 g for foods with low available carbohydrates content. Three items in candy and confectionary category (Tic Tac – two flavor- and Mon Cheri) were administered in smaller portion (12.5 g of available carbohydrates) because of the unrealistic portion and the alcohol content, respectively. Pasta and wholegrain cereal samples were cooked following the same procedure for each food: one portion of pasta or wholegrain cereals was cooked in 1 liter of boiling water with 5 g of salt for the time indicated on the pack label. Each meal was consumed with 500 ml water at a comfortable place within 14 min.

Experimental procedures

The volunteers attended each testing session after a 12 h overnight fast, having been instructed to consume the same meal the evening before each test day, and not to drink alcohol or to perform vigorous physical exercise. Furthermore, subjects followed a controlled diet the day before the test, excluding dietary fiber-rich foods to avoid any second meal effect [23]. Subjects consumed the food portion provided within 15 min, with 500 ml of still water as the only beverage. They remained seated during the 2 h of the study and were not permitted to further eat or drink until the end of session. The reference meal was glucose monohydrate (50 g or 25 g of available carbohydrates) dissolved in 500 ml of water and was consumed by the subjects in two or three occasions, at the beginning and end of the study. Generally, each group of volunteers tested from 2 to 10 food items.

Sample collection and blood glucose analysis

Blood glucose concentrations were measured in capillary whole blood obtained by finger prick (Accu-Chek Advantage System, Roche Diagnostics Limited, Lewes, UK) in the fasted state and at 15, 30 45, 60, 90 and 120 min after consumption of the test product. Blood samples were collected in a heparin/fluoride treated vials (Microvette CB 300 FH, Sarstedt, Germany) and stored at -20°C until analysis. Glucose concentration was measured by means of an automatic analyzer with a combined enzymatic-electrochemical detector (YSI 2300 STAT PLUS, Yellow Spring Instruments, OH, U.S.A.).

Data analysis

The incremental area under the blood glucose response curve (IAUC) was calculated geometrically using the trapezoid rule, ignoring the area below the fasting baseline. For each test food, the IAUC was expressed as a percentage of the mean IAUC of the isocarbohydrate reference food glucose, tested 2-3 times, consumed by the same subject. The GI of each food was then calculated as the mean value across all subjects consuming that food.

The GL (g glucose equivalents)/1000kJ values were calculated by multiplying the amount of carbohydrate contained in a 1000kJ portion of the food by the GI value of that food, which was then divided by 100.

Statistical analysis

The GI value in the database for each food was reported as mean (± SEM). Individual values overcoming the mean by at least 2 SD were excluded from the mean calculation, as specified in the ISO methodology [21].

Results and Discussion

Several groups of healthy volunteers (319 female, 305 male, total number 624) were recruited. The anthropometric characteristics of subjects are reported in Table 1. In total 142 food items were tested from 13 food categories. The measured GI values of the foods are shown in Table 2. For each food item, in addition to mean GI, the minimum and the maximum values are reported. GL values were calculated for 1000 kJ and not related to portion because it is difficult to define the serving size for each item since portion sizes vary markedly among food industries and consumers. Thus, expressing the glycemic effect of foods on an isoenergetic basis is a logical and practical approach. In addition, the year in which foods were analyzed is also shown. This information is necessary because the GI values of commercial foods might change over time if food manufacturers make changes in the ingredients or in the processing methods.

The variability observed in the GI value for foods of similar nature and category could reflect real differences among the foods. Food factors that can influence the GI of processed foods include processing, preparation and cooking methods, the physical form of the food, the type of sugars and starch, the presence of other macronutrients and antinutrients, and the ripeness or the maturity of the raw materials. For example, different brands of the same type of food, such as a size of pasta, may look and taste almost the same, but differences in the type of flour used, the technological aspects (time/temperature/humidity drying cycles; extrusion dies) and the cooking time can result in differences in the degree of starch gelatinization and consequently the GI values. This is evident comparing the three analyzed spaghetti (i.e., classici, n° 5 and n°12).

The variability in GI values within the same category, or subcategory, is comparable with the variability of the international GI data [24,25].

CONCLUSION

We measured the GI values of 142 different carbohydrate-rich foods. The relevance of the data obtained is that they refer to local Italian food items. Since there is a need to improve amount and quality of information on GI/GL available to the general public and to health professionals for health prevention, an Italian database including local foods commonly consumed is of value. For example, substituting high for low GI version of food within the same category will make a significant contribution to reducing the GI of the Italian diet. Moreover, an updated and expanded database of GI/GL of Italian foods will result in more reliable data for all clinical and research applications in the local contest. Finally, information on GI/GL of industrial products could motivate food manufacturers to develop a greater range of low-GI processed foods. Further studies are needed to investigate how the GI value of a food changes when it is consumed the way it is expected to be consumed in the context of a mixed meal (e.g pasta with sauce, jam with bread etc.). Such additional data will help both researchers and the consumer in making the correct selection of carbohydrate-based foods.

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Declaration of interest

The authors declare that they have no competing interests.

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