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Report

New information on carbohydrates in the Brazilian Food Composition Database

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ABSTRACT

Foods that contain unavailable carbohydrates may lower the risks for some non-transmissible chronic diseases because of the potential benefits provided by the products of colonic fermentation. On the other hand, foods that are sources of available carbohydrates may have higher energy value and increase the post-prandial glycemic response. The biomarker glycemic index and the resulting glycemic load may be used to classify foods according to their potential to increase blood glucose. Information about glycemic index and glycemic load may be useful in diet therapy. Currently, food composition tables in Brazil do not provide data for individually analyzed carbohydrates even though some quality data are available in scientific publications. The objectives of this work were to produce and compile information about the concentration of individual carbohydrates in foods and their glycemic responses and to disseminate this information through the Brazilian Food Composition Database (TBCA-USP). The glycemic index and glycemic load of foods were evaluated in healthy individuals. Concentrations of available carbohydrates (soluble sugars and available starch) and unavailable carbohydrates (dietary fiber, resistant starch, beta-glucans, fructans) were quantified by official methods, and other national data were compiled. TBCA-USP (http://www.fcf.usp.br/tabela), which is used by professionals and the population in general, now offers both chemical and biological information for carbohydrates.

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1. Introduction

Carbohydrates are important for human health because they are a primary source of energy and have beneficial effects resulting mainly from dietary fiber and other unavailable carbohydrates that are resistant to digestion. Colonic microbiota ferments, partially or totally, the carbohydrates that escape digestion and absorption in the small intestine and produce, mainly, short chain fatty acids. The products of fermentation cause several beneficial effects both locally and systemically (Elia and Cummings, 2007; Gray, 2006). Some unavailable carbohydrates (dietary fiber, resistant starch, beta-glucans and fructans) may lower risks for some non-transmissible chronic diseases (NTCD), such as diabetes, obesity, cardiovascular diseases and cancer (Gray, 2006; WHO/FAO, 2003).

One important role of carbohydrates is the glycemic response, which differs depending on the food source and on extrinsic and intrinsic factors that affect carbohydrate digestion and absorption. The biomarker glycemic index (GI) and the resulting glycemic load (GL) may be used to classify foods according to their potential to increase blood glucose. The GI distinguishes food carbohydrates based on their potential to increase the glycemic response after the ingestion of a fixed amount of available carbohydrates (50 g or 25 g) in relation to the ingestion of the same amount of carbohydrates from a standard food (white bread or glucose) (Jenkins et al., 1981). The GL reflects dietary glycemic impact and is calculated by multiplying the GI of each food (using glucose as the standard) by the amount of available carbohydrate in the consumed food portion (Salmeron et al., 1997).

Studies on GI are important because of potential physiologic and therapeutic effects of low GI diets for healthy individuals, as well as for those who are obese, diabetic and/or hyperlipidemic (Venn and Green, 2007; Brand-Miller, 2003; WHO/FAO, 2003; Augustin et al., 2002). The global strategy on diet, physical activity and health, proposed by WHO (2004), aims to control and prevent NTCDs, and considers, among other things, that consumers have the right to receive exact, standardized and understandable information about food product content, so that it is possible for them to make healthy food choices. The use of GI as a tool to facilitate food planning through glycemic control has been used and encouraged in some countries (SUGIRS, 2007; Danone Vitapole/FAO, 2001; Frost and Dornhorst, 2000).

In Brazil, there is not much information about the different carbohydrate fractions in foods or about the biological availability of carbohydrates when consumed. At the same time, there is a high incidence of NTCDs, which were responsible, in 2001, for 62% of all

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deaths and 39% of all hospitalizations registered in the Brazilian public health system (Brasil, 2005; Wang et al., 2002; Narayan et al., 2000). Cardiovascular diseases accounted for 31% of all known deaths (Brasil, 2005).

The Brazilian Food Composition Database (TBCA-USP), developed and updated by the Brazilian Network of Food Composition Data Systems (BRASILFOODS), has aimed to provide quality information about Brazilian food composition since its creation in 1998 (USP, 1998). BRASILFOODS, housed in the University of Sao Paulo, Department of Food Science and Experimental Nutrition of Pharmaceutical Science School (Menezes et al., 2002), is connected to INFOODS (International Network Food Data Systems) and LATINFOODS (Latin American Network of Food Composition Data Systems) and has been cooperating with the *Tabla de Composición de Alimentos de América Latina* (FAO/LATINFOODS, 2000). TBCA-USP currently has a total of 1838 food items, 1200 of which contain proximate composition of raw, cooked and industrialized foods and recipes (Giuntini et al., 2006). In this database, the carbohydrates were estimated by difference (available carbohydrates) to calculate energy, and data on dietary fiber was determined by an enzymatic-gravimetric method (Lee et al., 1992). However, it has been suggested that the presentation of carbohydrates by difference should be eliminated from food composition tables (Greenfield and Southgate, 2003; FAO/WHO, 1998). These estimates are not sufficient for users' needs in view of the fact that the physiological effects of each carbohydrate fraction may be important in lowering risks for NTCDs (Gray, 2006; FAO/WHO, 1998). Quantifying each individual carbohydrate and evaluating foods on a case-by-case basis is the current tendency of worldwide databases (Greenfield and Southgate, 2003; Li et al., 2002; Monro and Burlingame, 1996). The goal for TBCA-USP is to have data for individual carbohydrate fractions for foods that are sources of carbohydrates. Having data for available and unavailable carbohydrates is also important for the accomplishment of the global strategy on diet, physical activity and health.

2. Objectives

The objectives of this work were to produce and compile information about the concentration of the different carbohydrates in foods and their glycemic effects and to disseminate this information through the TBCA-USP.

3. Methodology

The data for individual carbohydrates were obtained both by direct chemical analysis and by compilation. All the information related to the glycemic responses of Brazilian foods was obtained from studies using healthy volunteers at the University of Sao Paulo by BRASILFOODS.

3.1. Data compilation

To facilitate data compilation and to guarantee data quality and standardization, the *Form for Compilation of Food Composition Data*, developed by BRASILFOODS (Menezes et al., 2005) was updated. The spreadsheets for identification of foods, proximal composition and analytical quality control were not modified. However, a spreadsheet for carbohydrates was expanded to accommodate the wide range of individual carbohydrates in foods and to include data on glycemic response.

The first part of the form included the food identification. The INFOODS guidelines (Truswell et al., 1991) to describe foods were adopted with modifications made by LATINFOODS (FAO/LATINFOODS, 2004; FAO, 1995; Menezes et al., 2005).

The second part of the form contained different spreadsheets to be filled in according to the analytical methods used. The INFOODS tagnames for nutrients were adopted to improve data interchange (Monro and Burlingame, 1996; Klensin, 1992).

The content of carbohydrates in foods can be determined according to several procedures, which vary according to the type of carbohydrate and its methodology of analysis (Monro and Burlingame, 1996). Total carbohydrates can be calculated by the aggregation of compounds (the sum of available carbohydrate values analyzed individually by specific methods) or by difference (100 g—the sum of proximal composition values per 100 g). Carbohydrates calculated by difference were not useful for this database; however, this information was documented and stored for possible consultation. Available carbohydrates can be analyzed individually, i.e., monosaccharides, disaccharides and polysaccharides obtained by direct analysis. Dietary fiber can be determined according to analytical methods (gravimetric). Monosaccharide compounds of dietary fiber can be obtained by non-gravimetric methods. Other compounds such as polysaccharides and cell wall fractions that would also be classified as dietary fibers can be obtained by specific analysis.

The form for compilation of food composition data was structured to accommodate the main patterns and methods of analysis for carbohydrates used by national researches and in the national data publications. Sources of all information (laboratory or bibliographic reference) are documented in the TBCA-USP.

3.2. Studied foods

The foods selected for the evaluation of glycemic response are all habitually consumed by the Brazilian population according to a Brazilian research on family budget, done between 2002 and 2003 (IBGE, 2004). The products were provided by CEAGESP, a company that centralizes food marketing in the state of Sao Paulo and receives foods that are produced in the whole country. Depending on the food characteristics, the most commonly consumed kinds or preparations were selected (for example, maturation state, raw or cooked, time of cooking, among others); all this information was documented when identifying the food. For carbohydrate determination, all samples (raw and cooked ones) were lyophilized and stored at −20 °C. Foods that needed to be cooked were prepared on the day of the clinical assay. After this, the samples were lyophilized, milled to a particle size of <0.250 mm and frozen, for later completion of chemical analysis (triplicate samples). In the case of commercial bread, a composite sample was made from samples of the same kinds of bread produced in three different weeks, with consideration for the number of industries and their representativeness in the market.

In the case of data compiled from published sources, the food was identified from information available in the publication.

3.3. Quantity of food consumed

The quantity of food to be consumed by the healthy volunteers was calculated based on its content of available carbohydrate. This content is calculated by the sum of the concentration of soluble sugars (mainly glucose, fructose and sucrose) and available starch (the difference between total starch and resistant starch) in the food. Depending on the sample characteristics, the quantity of available carbohydrate to be ingested was 25 g or 50 g; the same amount of available carbohydrate was ingested in the standard food (white bread) (Brouns et al., 2005). Some fruits had to be consumed dried due to their reduced concentration of available carbohydrates. In the case of commercial breads, the amount consumed was a proportion of the bread produced in each of three industries.

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