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Toward a more standardised and accurate evaluation of glycemic response to foods: Recommendations for portion size calculation

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ABSTRACT

This study aimed at evaluating the adequacy of calculation methods for portions to be provided to subjects in clinical trials evaluating glycemic response to foods. Portion sizes were calculated for 140 food samples, based on Nutrition Facts labels (current practice) and actual available carbohydrate content (current recommendation), and compared against the amount of monosaccharides yielded by the digestive breakdown of their actual available carbohydrate content (basis for glycemic response to food). The current practice can result in significant under- or over-feeding of carbohydrates in 10% of tested cases, as compared to the targeted reference dosage. The method currently recommended can result in significantly inadequate yields of monosaccharides in 24% of tested cases. The current and recommended calculation methods do not seem adequate for a standardised evaluation of glycemic response to foods. It is thus recommended to account for the amount of absorbable monosaccharides of foods for portion size calculation.

1. Introduction

Glycemic response to foods is a major current interest due to its putative relationship to chronic diseases, such as diabetes, cardiovascular disease or obesity (Howlett & Ashwell, 2008; Livesey, Taylor, Hulshof, & Howlett, 2008). As a result, glycemic response to various foods has been used for educational and food choice guidance purposes toward populations at risk with diabetes, obesity, insulin resistance or cardiovascular diseases (Burton, Monro, Alvarez, & Gallagher, 2011; Cândido, Pereira, & Alfenas, 2013; Kinmonth, Angus, Jenkins, Smith, & Baum, 1982) and for substantiation of health claims by manufacturers (European Food Safety Authority, 2012).

As stated previously, "both the quality and quantity of carbohydrate determines an individual's glycemic response to a food or meal" (Barclay, Brand-Miller, & Wolever, 2005), whether the measured outcome is blood glucose peak concentration and timing, rate of blood glucose clearance, glycemic index, glycemic load, glycemic impact (Monro & Shaw, 2008). Such clinical trials are usually designed to provide a fixed amount of "available" or digestible carbohydrates, usually between 25 and 50 g per subject (Brouns et al., 2005; Kendall et al., 2006; Najjar et al., 2009; Robert & Ismail, 2012; Thondre, Wang, Rosenthal, & Henry, 2012). Portion sizes of foods provided to the subjects are calculated accordingly and are critical for guaranteeing a standardised evaluation of glycemic response to foods.

For commercially available foods, portion sizes are usually calculated using the carbohydrate content per serving displayed on a Nutrition Facts label, using a simple multiplication procedure (Jenkins, Kacinik, Lyon, & Wolever, 2010; Jenkins et al., 2008; Nilsson, Östman, Holst, & Björck, 2008; Thompson, Winham, & Hutchins, 2012; Thondre et al., 2012; Wong, Mollard, Zafar, Luhovyy, & Harvey Anderson, 2009):

$$\text{Portion served} = \frac{\text{Amount of available carbohydrate to be fed} \times \text{Food serving size (from label)}}{\text{Amount of available carbohydrate per serving size (from label)}}$$

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In this case, "available carbohydrates" are total carbohydrates excluding dietary fibres. However, in most regulations, there is a 20% tolerance on the total carbohydrate content displayed on the label relative to the actual carbohydrate content determined by approved chemical methods (Code of Federal Regulations., 2002; European Commission: Health and Consumer Protection Directorate General, 2006). Hence, if Nutrition Facts data are used to calculate portion sizes to be ingested by subjects of clinical trials, there is potential for an error as high as 20% on the amount of carbohydrates actually fed.

An approach to decrease variability in portion size estimation appears in guidelines recently suggested by the International Organization for Standardization (IOS) (International Organization for Standardization., 2010), stating that portion sizes calculated should be based on the actual carbohydrate content of food samples. However, most studies published since then and to date are still based on Nutrition Facts labels and, to our knowledge, no study has used measured carbohydrate content from marketed products taken off the store shelf to evaluate the actual impact of following the IOS recommendation.

Additionally, what is measured in the evaluation of the glycemic response to foods is glucose concentration in blood, as the result of the digestion of carbohydrates, the absorption of their resulting monosaccharides (glucose, fructose and galactose) to the blood stream and the conversion of fructose and galactose into glucose (Mathers & Wolever, 2009). Due to the chemical nature of the digestive processes (essentially, a hydrolytic reaction involving water), the amount (mass) of monosaccharides resulting from the breakdown of starch, sucrose, maltose or lactose (referred to as "complex carbohydrates" from this point on) fed is not equal to the amount (mass) of complex carbohydrates fed, as shown in Fig. 1. Hence, if actual available carbohydrates content is used to calculate portion sizes to be ingested by subjects of clinical trials, regardless of the form of these carbohydrates, there is potential for an error in standardization of the amount of carbohydrates actually fed. While the IOS recommends considering the actual available carbohydrate contents of foods, regardless of their form, it may then be recommended to account for the amount of absorbable monosaccharides in food samples when portion sizes are calculated. Thus, the actual impact of following such portion size calculation recommendation must be evaluated, in order to support methodological recommendation for the setup of clinical trials for glycemic response evaluation.

The objective of this study was to evaluate the impact of different portion size calculation methods, from Nutrition Facts information and from actual available carbohydrate content regardless of

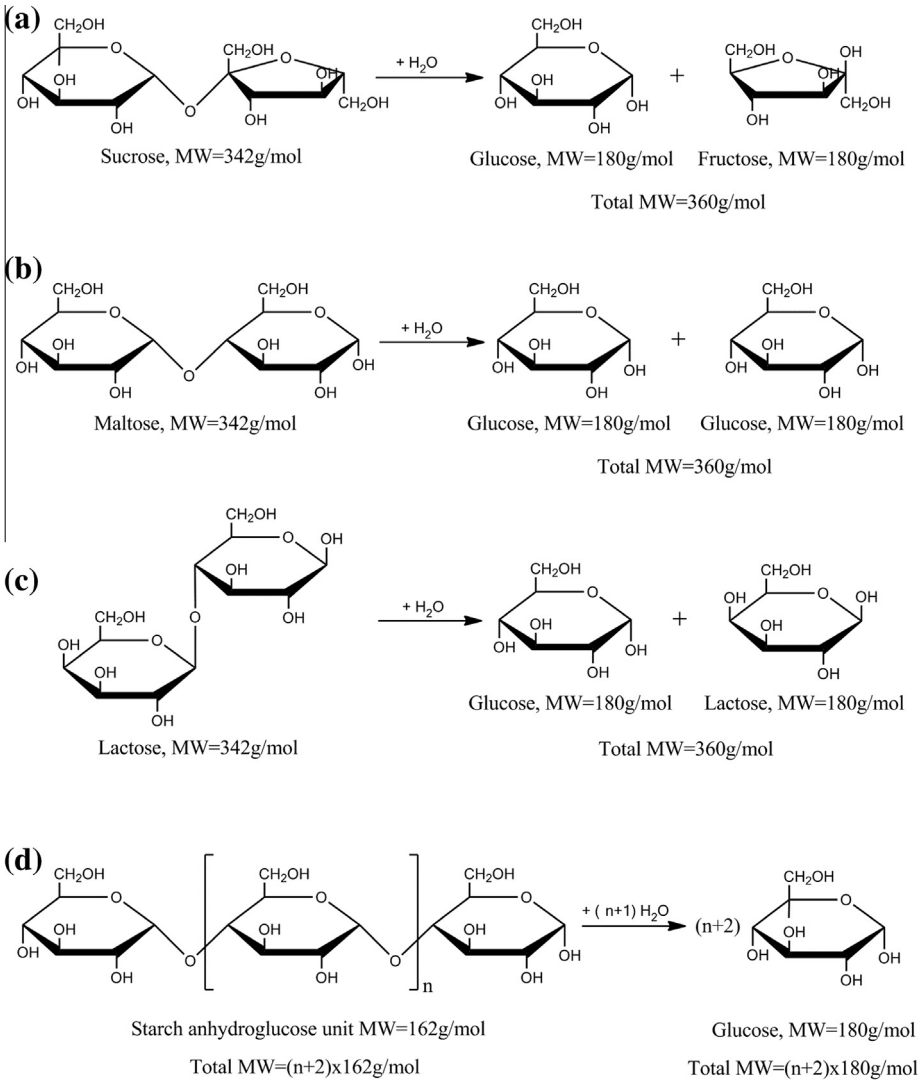

Fig. 1. Molecular weights of sucrose (a), maltose (b), lactose (c), starch (d) and their digestion products.