# FOOD DETERMINANTS FOR SPECIFIC DIETARY CARBOHYDRATES

Gerald G. Dull
USDA-ARS, Russell Research Center, Athens, GA

W. O. Caster
Rural Health, Georgia Southern College, Statesboro, GA

## INTRODUCTION

Food macronutrients are conveniently classified into three broad categories which are proteins, lipids, and carbohydrates. These categories are further defined by considering specific chemical constituents. Compilations like Handbook 8 provide listings for specific constituents such as the individual fatty acids in lipids and individual amino acids in proteins. However, in the case of carbohydrates the data are generally listed as total carbohydrates and that value is obtained by difference between the dry matter and the sum of protein, lipids and ash.

With the advent of more rapid and specific analytical procedures like paper chromatography and high performance liquid chromatography (HPLC), publications giving concentrations of specific sugars in foods have become more numerous (1-4, 6, 7).

As is true with any nutrient, there is some difficulty in assigning a specific concentration for a sugar in a food. To illustrate the type of variation in composition one might expect, consider the changes in sugars in cantaloupe flesh as the fruit develops on the vine. Sucrose ranges from 0 to 6 % while glucose and fructose each vary from 1 to 2.5 %. An eating ripe fruit could be expected to have an average composition of 6.0, 1.6, and 1.7 % sucrose, glucose, and fructose, respectively. These values may vary with different cultivars. In spite of these variations, it is possible to assign a workable concentration for specific sugars in an eating ripe fruit. One should never lose sight of the fact that these values are averages and a "best estimate".

In addition to the most commonly occuring sugars, sucrose, glucose, and fructose, current analytical technology allows for rapid determination of other monosaccharides, and oligosaccharides which are carbohydrates that yield from 2 to 9 monosaccharides upon acid hydrolysis. This group of carbohydrates includes stachyose and raffinose. Recent advances in the manipulation of plant morphogenesis implicate oligosaccharides as critical biochemical regulators (8). With findings such as these, it can be expected that even more significant advances in oligosaccharide separations and characterizations will be developed. Although it is speculative, the development of new information about specific oligosaccharides may well lead to an understanding of their role in human physiology.

In work with onions, it has been shown (4, 5) that there are at least 7 fructosans (oligosaccharides containing fructose) ranging in size from 2 to 7 sub-units of fructose.. In a high dry matter onion, carbohydrates comprise over 80 % of the dry matter. The fructosans account for approximately 60 % of the carbohydrates.

As future research elucidates roles for specific simple sugars, oligosaccharides, and polysaccharides, the need for analytical data on these constituents will increase. Clearly, there is a lot of analytical work to do in order to develop a comprehensive data base for specific carbohydrates. The purpose of this presentation is to demonstrate the kinds of data that are available now, and how these data can be used delineate food determinants for specific carbohydrates in specific diets.

## RESULTS AND DISCUSSION

The data used in this presentation are are taken from a study on food and nutrient intake patterns of older men and women in Evans County , Georgia. This study has been presented in detail elsewhere (5). In this work it has been possible to look at several categories of carbohydrate intake, which include total carbohydrates, fiber, starch, total sugars, glucose, fructose, sucrose, lactose, and stachyose. For example, it is possible to look at an overall picture like the daily total carbohydrate intake or a specific case like the daily intake of glucose.

It is also possible to analyze the same data to establish which foods determine the major portion of the daily intake of specific sugars. The food consumption patterns were examined in light of high and low consumption of a specific sugar such as glucose. All of the data for the men were arranged in decreasing order according to the amount of the daily glucose intake. Those men in the top quartile were considered high consumers of glucose and those in the bottom quartile were low consumers. The average amount of glucose consumed by the high and low groups was 20.0 and 3.3 g/day, respectively. The foods providing significant amounts of glucose were orange juice, grapefruit and lemonade. Seventy percent of the glucose intake in the high group was derived from these three food sources.

The same food determinant analysis was run for fructose, sucrose, lactose, and stachyose. The high and low fructose intakes were 20.2 and 3.1 grams/day, respectively and are essentially the same as those for glucose. A significant difference occurs in that the major fructose source is apple products. Also, it should be noted that specific fruits (pears and peaches) played a more significant role in supplying fructose. In each of these cases it is noted that those individuals with high intakes of a specific sugar, ingest added amounts of a key food. This should not be taken as implying that their total caloric intake is increased. It is not. All energy intakes in these groups are about the same. As one food increases, another food or group of foods decreases. In part, this is random. In part, however, there are consistent and statistically significant decreases noted in specific foods.

The story with sucrose differs markedly from that for glucose and fructose. The total intake for both groups is higher (107 and 35 grams/day for high and low groups, respectively) and the three major sources are sugar, soft drinks, and candy. These foods are considered to be highly processed products. Even in the low intake group there are small amounts of cookies, cakes, jam, jelly, fruits, and ice cream present. Some of the men, however, seemed to have the proverbial "sweet tooth". They sprinkled more sugar on their foods and had candy and soft drinks for snacks.

The daily lactose intake was 30 and 3 grams for the high and low groups. Obviously, milk sugar comes from milk and milk products. The extremes of intake are noteworthy. A certain minimal amount of milk solids appears in a number of foods--particularly those providing the major amount of lactose in the low group. The big difference between high and low is to be found in the consumption of fluid milk. Some men were "milk drinkers" and others were not. Measuring the lactose intake provides one of the cleanest ways of distinguishing between these groups.

Stachyose is of interest because of its association with flatulence. The intake of stachyose was 0.66 and 0.03 g/day for the high and low groups. The major sources were dried peas and beans.

One of the important things to note was that there were relatively few foods which were consumed in significantly higher amounts by the high group than the low group and in the case of each sugar were considered major food determinants. Those determinant foods were oranges, grapefruit, apples, pears, peaches, sugar, soft drinks, candy, milk, dry peas, and beans. That is 11 foods. When you add to this another list of about 10 foods (beets, turnips, bread, cookies, cakes, jams, jellies, and a few additional fruits and milk products) one has all the foods that provide appreciable amounts of the simple sugars in this older population. This is important to those building and using food tables. One can get a reasonable approximation of any sugar intake with a relatively modest number of foods. Furthermore, the concentration of simple sugars in most of these foods is readily available in the literature. Several references are provided which may help in efforts in this direction.

REFERENCES


1. Birth, G. S., Dull, G. G., Magee, J. B., Chan, H. T., and Cavaletto, C. G. 1984. An Optical Method for Estimating Papaya Maturity. J. Am. Soc. Hort. Sci. 109(1):62-66.

2. Birth, G. S., Dull, G. G., Renfroe, W. T., and Kays, S. J. 1985. Nondestructive Spectrophotometric Determination of Dry Matter in Onions J. Am. Soc. Hort. Sci. 110(2):297-303

3. Darbyshire, B., and Henry, R.J. 1979. The association of fructans with high percentage dry weight onion cultivars suitable for dehydrating. J. Sci. Food Agr. 30:1035-1038.

4. Dull, Gerald G. 1984. Measurement of Cantaloupe Quality With Near Infrared Spectrophotometry. Winter Meeting of Am. Soc. Agric. Eng. Paper No. 84-3557.

5. Hudy, S.P., Caster, W.O. and Hames, C.G. 1985. Changes in Food and Nutrient Intake Patterns Observed in Older Men and Women in Evans County, Georgia. J. Clin. Experimental Geront. 7(2):99-113.

6. Lee, C. Y., Shallenberger, R. S. and Vittum, M. T. 1970. Free sugars in fruits and vegetables. New York State Agric. Expt. Sta., Geneva. New York's Food and Life Sciences Bulletin No. 1, p 1 - 12.

7. Meredith, F.I., Thomas, Charles A. and Heggestad, Howard E. 1986 Effect of the Pollutant Ozone in Ambient Air on Lima Beans. J. Agr. Food Chem. 34(2):179-185.

8. Van, Kiem Tran Thanh, Patrick Toubart, Alain Cousson, Alan G. Darvill, David J. Gollin, Paulanne Chelf, Peter Albersheim. 1985 Manipulation of the morphogenetic pathways of tobacco explants by oligosaccharins. Nature. 314:615-617.