

# Carbohydrates

By Jonathan W. DeVries, Ph.D

When a middle-aged man, tired of being fat and having trouble losing weight by traditional means happens upon a low-carbohydrate diet, he tries it for a few months happily watching as the pounds slip away without gnawing hunger and cravings. He writes a book about it that is a huge hit, even though the medical profession scorns it (1). While you may think this book appeared recently in light of the shifts going on in today's eating habits, it was, in fact, published in 1863. In today's versions, the Atkins Diet, the Zone Diet and the South Beach Diet have dramatically changed our thinking about "Carbs" (short for carbohydrates, one of the three major caloric macronutrient components of our diet along with fats and proteins).

## **CHANGES in CONSUMER DESIRES**

This recent low carbohydrate trend is driven by the consumer's desire for better health, in particular better health through weight reduction. According to ongoing surveys, at any given time, more than 50% of consumers have a desire to "lose weight". There may be a slight variation in the actual percentage year by year, but nonetheless, more than one person in two would like to shed pounds. However, willingness to shed pounds doesn't necessarily translate into actions that lead to weight loss if it means life style changes that are uncomfortable. People generally want to lose weight but still eat at a comfortable level. In other words, people want to "eat to lose weight"(2).

## **A NEW/EXPANDING MARKET**

Out of a population of approximately 28 million in the US, it is estimated that 10 million individuals are actively pursuing reduced carbohydrate dietary patterns. Foods in virtually every category (from apple juice to ziti pasta) have been modified to a lower glycemic carbohydrate level. It has been reported that in the past year 2 new low carb foods were introduced each day by the 4 leading low carb product producers. In addition, major restaurant chains such as Subway, Burger King, Blimpies, and TGI Fridays are adding low-carb alternatives to their menus (3).

## **INGREDIENTS GALORE**

Food ingredient suppliers have been very responsive to the food manufacturers needs in formulating and producing lower and lower glycemic foods. Table 1 lists a variety of ingredients available to food formulators to use in adjusting the glycemic carbohydrate level of a product. Many of these ingredients bring unique functionality to products, serving as reduced calorie fillers, moisture control agents, and fat mimetics.

## No-Carb and Low Carb – Labeling Issues

The various terms related to reduced carbohydrate dietary changes such as “low carb”, “no carb”, “net carbs” and “effective carbs” are not well defined

and have different meanings for different people. Although the US Food and Drug Administration (USFDA) has established labeling standards for “low”, “lite”, and “less” with regard to nutrients such as sodium and fat, no standard definition for low carbohydrate foods (“Low Carb”) has been adopted by any governmental organization in the US. With regard to the Nutrition Facts panel, the labeling requirements are very clear; ALL carbohydrates (glycemic and lower glycemic) in a food sample must be properly labeled as Total Carbohydrates per the regulations of the Code of Federal Regulations (CFR). The quantity of Total Carbohydrates is determined by subtracting the quantity of protein, fat, moisture, and ash from 100. The Insoluble Fiber can be subtracted from the total carbohydrates (available carbohydrates) when calculating calories. Two categories of lower glycemic carbohydrate components, namely dietary fiber (labeling required) and sugar alcohols (labeling optional) are quantitative entries in the Nutrition Facts panel. Other carbohydrates such as the organic acids which often produce a glycemic limiting

effect are not called out, but are lumped as other carbohydrates included in the Total Carbohydrates quantity. All Nutrition Facts panel must be factual and verifiable using appropriate methods such as AOAC International Official Methods of Analysis

as specified in the CFR.

Outside the nutrition facts panel, the labeling picture becomes less clear. Various packages have displayed values for “net carbs” or “effective carbs” frequently with a definition of the term

accompanying the quantity stated. Often “net carbs” is determined as the quantity of total carbohydrates less the carbohydrates (dietary fiber and sugar alcohols) that have a low impact on blood glucose levels. The FDA and the USDA have been concerned about the claims on labels outside the nutrition facts panel. Warning letters have been issued to reinforce the fact that ALL carbohydrates (analytically verifiable and properly calculated) must be included in the Total Carbohydrates of the Nutrition Facts Panel. Policy statements (4) and warning letters (5) have been issued indicating that it is a labeling violation to say: “Low Carbohydrate (not defined)”; “Carb Free”; “Only x grams of Carbohydrates per serving”; “Just X grams of carbohydrate”; or “50% Less Carbohydrates than xxx”. If the label declares “Sugar Free”, but contains sugar alcohols they must be declared per 21 CFR 101.9(c)(6)(iii). Factual statements such as “7 grams of carbohydrate” are permissible as long as they do not implicitly characterize the level of the nutrient (4). USDA FSIS specifically indicates no objection to statements that do not expressly state or imply a specific level of carbohydrates or to “Net Carbs”, “Effective Carbs”, and “Net Impact Carbs” when used in manner that is truthful and not misleading.

Because there are no regulatory definitions of these terms, they must be accompanied by information regarding their meaning and how they are calculated.

### Table 1 INGREDIENT ALTERNATIVES to TRADITIONAL CARBOHYDRATES

#### PROTEIN SOURCES

Soy Protein Concentrates  
Soy Protein Isolates  
Whey Protein Concentrates

#### RESISTANT POLYSACCHARIDES

Resistant Starches      Inulin

#### RESISTANT OLIGOSACCHARIDES

Trans-Galactooligosaccharides  
Fructooligosaccharides  
Resistant Maltodextrins

#### SUGAR and RELATED ALCOHOLS

Sorbitol	Maltitol
Lactitol	Xylitol
Mannitol	Erythritol
Glycerol	Isomalt
Tagatose	

#### GUMS/MUCILAGES/Other

Psyllium	Acacia
Guar (partially Hydrolyzed)	
Aliginates	Tragacanth
Carob Bean	Locust Bean
Xanthine	Oat Gum

## **ANALYTICALLY SPEAKING**

Accurate quantitation of food nutrients is essential to generate the nutrition facts panel for any food. Accurate quantitation of carbohydrates is no exception. And, as researchers move beyond traditional ingredient profiles, additional considerations and concerns surface with regard to analysis of those products.

**TOTAL DIETARY FIBER** - The AOAC dietary fiber method, (AOAC International, Official Methods of Analysis, 985.29, Total Dietary Fiber in Foods) has been the international standard for the digestion resistant portion of the food sample since the early 1980's. The accepted definition of dietary fiber states: Dietary Fiber consists of the remnants of edible plant cells, polysaccharides, lignin, and associated substances resistant to (hydrolysis) digestion by the alimentary enzymes of humans. Dietary fiber is determined by digesting the food sample with enzymes simulating the human digestive system, to remove all digestible material. The dietary fiber is then precipitated with alcohol, filtered and measured gravimetrically. Fiber materials such as psyllium require special attention due to difficulties in handling the mucilaginous precipitate, which forms when the alcohol is added to the digested sample.

**SUGAR ALCOHOLS** - Sugar alcohols such as sorbitol, maltitol, lactitol, erythritol, and xylitol are considered non-glycemic, but do impart a degree of sweetness to a product. If sugar alcohols are being used in a product, it is best to advise the laboratory conducting the analysis of their presence, particularly if there are sugars in the product as well. While the quantitation of sugar alcohols is readily carried out, sugar alcohols can interfere with sugar assays and vice versa.

**POLYFRUCTANS (Inulin and Fructooligosaccharides)** - Polyfructans, are soluble dietary fibers. In fact they are so soluble that they are not effectively quantitated using standard dietary fiber technology. Rather, AOAC Official Method 997.08, Fructans in Food Products must be used. To effectively quantitate polyfructans one must first hydrolyze them and measure the fructose released during the hydrolysis. The fructose released is then measured by HPLC. To assure against "double counting", the analyst also

must hydrolyze the inulin in the sample during the course of the traditional fiber analysis, since a small portion of inulin will be quantitated as dietary fiber by the traditional methods.

**RESISTANT STARCHES** - Resistant starches are divided (somewhat arbitrarily) into four categories; RS1, RS2, RS3 and RS4. Resistant starches that are highly resistant to digestion generally are determined as dietary fiber during the standard dietary fiber analysis. AOAC Official Method 2002.02, Resistant Starch in Starch and Plant Materials, for the analysis of resistant starch is available, but is applicable primarily to RS2 and RS3. However, when used in combination with standard dietary fiber methodology, the total digestion resistant carbohydrate quantity of the sample will be overstated. A further issue with resistant starch involves processability. In some cases, the resistance to digestibility of resistant starch is lost during processing. For example, raw potatoes are very high in resistant starch. When the starch is gelatinized with heat, it becomes very digestible, however on cooling, the starch retrogrades and becomes digestion resistant. Thus, when a resistant starch ingredient has been formulated and processed into a product, the quantity of dietary fiber found analytically may not match the quantity of dietary fiber calculated based on ingredient analyses and formulation.

**RESISTANT MALTODEXTRINS** - Resistant maltodextrins (e.g. Fibersol) begin as starches that are hydrolyzed to short chain dextrins. The glucose to glucose linkages are then rearranged either thermally, or with acid from their usual alpha 1,4-configuration, rendering the resulting molecule resistant to digestion by the enzymes of the human alimentary system. Because the molecules are dextrins, they do not precipitate during the dietary fiber assay and require a special HPLC procedure to quantitate. AOAC Official Method 2001.03, Total Dietary Fiber in Foods Containing Resistant Maltodextrins is used to quantitate resistant maltodextrins.

**POLYDEXTROSE** - Polydextrose is produced by using an organic acid such as citric acid to polymerize a mixture of glucose and sorbitol to a randomly

linked polymer of 8-10 carbohydrate units. Because the carbohydrate units are randomly linked, the resulting molecules are almost completely resistant to digestion by the human alimentary enzymes. Because of the unique nature of the polydextrose molecules, analysis is carried out by digesting the remainder of the food sample away from the polydextrose, then quantitating the polydextrose using an HPLC system equipped with an electrochemical detector, per AOAC Official Method 2000.11, Polydextrose in Foods.

**PROTEINS** - Proteins have long been substituted for carbohydrates in diets of those wishing to reduce carbohydrate intake. Protein also affects the carbohydrate calculation for a nutritional label. Different factors are used in the protein calculation based on the protein source of the product. This, in turn, will affect the carbohydrate results. Proteins are analyzed by traditional Kjeldahl methods or by combustion methods such as AOAC Official Method 992.23, Crude Protein in Cereal Grains and Oilseeds, or Generic Combustion Method.

## REFERENCES

1. Willett, W.C., and Skerett, P.J. in Newsweek, January 19, 2004 referring to William Bantings "Letter of Corpulence, Addressed to the Public", London, 1863.
2. Harry Balzer, Personal Communication
3. Harry Balzer, Personal Communication
4. [www.fsis.usda.gov/OPPDE/larc/Policies/carbLabel/](http://www.fsis.usda.gov/OPPDE/larc/Policies/carbLabel/)
5. <http://www.fda.gov/foi/warning.htm>

A publication of Medallion Labs  
Dr. Jonathan DeVries, Editor

If you would like to know more about Medallion Labs or would like to submit samples, please visit our website at [www.medallionlabs.com](http://www.medallionlabs.com) or call us at 800.245.5615.

### **IMPORTANT INFORMATION THE LAB NEEDS TO KNOW:**

Because of the unique characteristics of products with "low carb" ingredients, the laboratory faces unique analytical challenges. It is very important to provide information about your samples in order for the lab to provide the best analytical results possible.

Include estimates of the quantity of the various ingredients at the time the samples are submitted. Very often the quantity of reagents necessary to successfully conduct an analysis is dependent upon the quantity of analyte present. Thus, providing this information to the analyst allows for adjustment of sample size to optimize the analytical procedure. It is helpful to note if the sample has more than 20% protein or more than 10% fat.

Indicate any special ingredients used in the product, particularly **resistant starch, resistant maltodextrins, polyfructans (inulin or fructooligosaccharides), polydextrose, and sugar alcohols**. Be particularly explicit if combinations of the above are present, since combinations often require special analytical considerations to assure one analyte does not interfere with another.

Results will be reported in terms of the nutrition facts label; therefore an accurate serving size is needed to assure accurate calculations. Since "net carbohydrates" or "effective carbohydrates" are not included in the nutrition facts panel, this information will not appear in the analytical report.