CARBOHYDRATE NEWS

Providing the most current and practical scientific information on carbohydrate and its role in nutrition and health

Evolving Evidence and Continuing Controversies in Carbohydrate Nutrition

On November 9-10, 2001, the Department of Interprofessional Continuing Education of the University of British Columbia, in cooperation with the Canadian Sugar Institute and other sponsors, held a two-day conference that explored current scientific and consumer issues in carbohydrate nutrition. Over 220 dietitians and health professionals attended. Full program available at www.sugar.ca.

This special edition of *Carbohydrate News* provides summaries of those presentations focusing on scientific issues in carbohydrate nutrition. While space limits coverage of all presentations, we would also like to acknowledge the contributions of: Susan Barr, PhD, RD, Professor, University of British Columbia; Mary Bush, MSc, RD, Acting Director, Office of Nutrition Policy and Promotion, Health Canada; Laura Kalina, RDN, MAd Ed, Founder, Shop Smart Tours; Bretta Maloff, RD, MEd, Leader, Community Development, Calgary Health Authority; and Diane Morris, PhD, RD, President, Mainstream Nutrition.

Introduction: Carbohydrate Complexities

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In the past, carbohydrate was typically in the shadow of other nutrients, receiving little attention from health professionals. However, developments over the past decade have shifted carbohydrate and its components into the nutritional spotlight.

With this increased interest in carbohydrates, paradigm shifts are occurring. Gaps in tables of food composition for carbohydrates are gradually being filled. Traditionally, carbohydrates in food have been determined by "difference" after analyzing other food constituents. Realizing the limitations of this method, many food databases are beginning to use direct chemical analysis to provide quantitative estimates of the various carbohydrate components. Unfortunately, there continues to be limited information on the intake of carbohydrate constituents (e.g. sugars) since much of intake data is based on food disappearance data. There are discrepancies between disappearance and actual intake – one calculation demonstrated sugar consumption by disappearance to be 25 teaspoons (per person per day) more than actual intake. Thus, there is a recognized need for accurate intake data.

The definitions of carbohydrate and its constituents are evolving. Recent definitions encompass the physiological and chemical nature of the carbohydrate, metabolic responses, and the implications to health (1). These definitions classify dietary carbohydrates into sugars, oligosaccarides, and polysaccharides (see table below).

Dietary Carbohydrate	Sub Group	Components
Sugars (1-2 polymers)	Monosaccharides Diasaccharides Polyols	glucose, galactose, fructose sucrose, lactose, maltose sorbitol, mannitol
Oligosaccharides (3-9)	Malto-oligosaccharides Other oligosaccharides	maltodextrins raffinose, fructo-oligosaccharides
Polysaccharides (>9)	Starch Non-starch polysaccharides	amylose, amylopectin, modified starches cellulose, pectins

Today, research and debate are focusing on the physiological effects of carbohydrates and their components. There is immense deliberation among nutritionists regarding the amounts, types and sources of carbohydrates required for optimal health outcomes including their effects on dental health, athletic performance, bowel function, diabetes, body fatness, and weight loss and maintenance. For example, research is focusing on glycemic index (GI), a parameter for characterizing the physiological effects of carbohydrate foods and the health consequences of low versus high GI diets in people with diabetes. Another area of research is investigating the concept of an ideal macronutrient mix and the health implications with varying macronutrient ratios. These research findings could have major implications for food guidance and dietary recommendations.

The science of carbohydrates is continually emerging - creating great debate and discussion in this area. The following summaries will help shed light on the evolving evidence and continuing controversies in carbohydrate nutrition.

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Carbohydrate Intake in Canada:

What We Know and What We Don't

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It is commonly assumed that intakes of carbohydrate, especially sugar, are high and increasing in Canada. In fact, because of methodological and practical reasons outlined below, actual intakes of carbohydrate and its components are not currently known.

Difficulties in determining carbohydrate intake

One problem with reports of intake of carbohydrate and its components is that these terms are not always defined, resulting in incorrect applications of the data. For example, the term "sugar" is used to refer to sucrose, added sugars, all sugars except lactose, or to all caloric sweeteners (e.g., corn syrup, glucose, honey). To minimize this problem, standard definitions for carbohydrate, such as the sum of sugars, oligosaccharides and polysaccharides (1), should be adopted.

To assess intake, the carbohydrate content of foods must be known. Unfortunately, two discordant methods of determining carbohydrate content have been used, resulting in limited ability to compare intakes across studies. In one method, used in databases in Europe and elsewhere, the mono, di, and polysaccharide content of foods are determined by direct analysis – the sum represents available carbohydrate. By contrast, in North America, carbohydrate is determined "by difference", meaning it is calculated by subtracting the weight of protein, fat, ash and moisture in a food from the total weight of the food. The latter method results in an overestimation of available carbohydrate because it includes non-carbohydrate compounds and non-available carbohydrates or fibre. For instance, the carbohydrate and energy content of a portion of spaghetti calculated directly is 50.6 g and 237 kcal (2), but is 64.6 g and 321 kcal "by difference" (3). Thus, North American data for carbohydrate and energy intakes are generally inflated compared to those published in Europe.

Both food availability and survey data have been reported as representative of actual intake even though these values are very different. Food availability, also referred to as disappearance or supply, is often incorrectly assumed to reflect actual intake. These data are based on production, imports and exports and represent all food *available* for consumption. However, actual intake is much lower because of wastage, spoilage, and non-food uses. Wastage varies among countries and may vary over time and for each nutrient within the same country. Thus, it is inappropriate to assume that food availability represents intake or that differences over time or among countries parallels changes in intake.

True intake can only be determined by dietary assessments such as food surveys. Unfortunately, food surveys are also limited in accuracy because of memory lapses, respondent burden, and intentional and unintentional exclusion of certain foods, all known as "under-reporting". True intake lies between food available for consumption and that reported to be consumed.

What we know about carbohydrate availability and intake in Canada

Although availability does not indicate actual intake, many have used these data to report trends over time. Energy availability in Canada has increased from 2800 kcal per capita per day in 1961 to 3200 kcal in 1999 (4). These values are likely much higher than actual intakes, estimated by U.S. surveys to be 2000 kcal (5), and depending on wastage, may or may not reflect an increase in intake. During this period, carbohydrate availability decreased from 53% of energy in the early 1960s to 49% in the early 1990s and levelled off at 51% during the late 1990s, whereas fat availability changed from 34% to 38% to 35% during the same period, and protein has been stable at about 13%. Sugar (sucrose) availability has decreased during this time, but total sugars availability (e.g. including corn syrup) is not known in Canada.

The 1972 Nutrition Canada survey was the most recent national food intake survey in this country (6). More recently, individual provinces have been conducting surveys that provide some indication of carbohydrate intake. The 1990 Quebec survey showed that grams per day of carbohydrate were lower than in 1972, whereas the percent of energy from carbohydrate was similar (7). By contrast, the 1994 Saskatchewan survey showed that percent of energy and grams per day of carbohydrate were higher than in 1972 (8). Hopefully, a clearer picture of carbohydrate intake will be evident once the provincial surveys are completed.

Individual assessment trends have also been determined by searching all reported studies where intake has been documented (9). These data show that in Canada, fat intake has decreased since the 1960s from about 40% of energy to about 32% in 2000 and carbohydrate has increased from about 50% to 55%. However, these data do not indicate changes in the absolute intakes of these nutrients.

No accurate data on intake of sugars in Canada exist because no recent surveys have been conducted, and only 43% of foods included in the Canadian Nutrient File food composition database have values for total sugars, and only 31% for sucrose. Thus, it is not currently known whether sugars intake has increased, decreased or stayed the same in Canada.

Until Canada adopts a database containing accurate information about the carbohydrate and carbohydrate components of foods, and completes a national food survey, intake data will continue to be guesswork.

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Carbohydrates and Weight Loss

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Obesity is a multifaceted disease that affects over 25% of Canadians. The determinants of obesity include a complex interaction between genetic, behavioral, environmental and physiological factors. The social, economic, and health implications of obesity are substantial and Canadians are trying several strategies to lose weight. The most popular weight loss practices reported by both men and women include dieting, exercise, and skipping meals (1).

Several dietary factors influence food intake and body weight. Increased energy density, alcohol intake, palatability and food availability tend to increase intake and may contribute to weight gain, whereas increased fibre intake and food volume tend to decrease intake and may assist in weight loss. The influence of energy balance, or the difference between energy intake and expenditure, on body weight and the importance of macronutrient composition of the diet are areas of intense study and debate.

Differences in the oxidation and storage among the macronutrients provides some insight into how each one would be expected to influence body weight. There exists a hierarchy for substrate oxidation based on the storage capacity of the body for each macronutrient and the body's ability to auto-regulate metabolism (2). Alcohol is at top of the hierarchy because there is no body storage capacity. Carbohydrates and proteins are next because there is tight regulation of their metabolism and minimal storage capacity. Both nutrients can readily adjust oxidation to intake. As well, carbohydrates are readily used by the body for energy. By contrast, fat has a very large storage capacity in the form of adipose tissue, and metabolism is less tightly regulated. Fat oxidation adjusts more slowly to fat intake. Thus, this hierarchy suggests that fat storage and weight gain are most likely to occur when fat, rather than protein or carbohydrate, is consumed in excess of energy needs.

Research has been conducted to determine whether there exists an ideal macronutrient mix for weight loss. The following table provides examples of studies that have assessed the impact of low energy diets, varying in energy from carbohydrate and fat, on weight loss. These studies show that regardless of the carbohydrate to fat ratio of the diets, weight loss patterns were similar. Thus, weight loss was associated with a reduction in total energy intake and not the nutrient composition of the diets.

These findings suggest that in contrast to the suggestions made by many popular diet books, when energy intake is reduced and kept constant, weight loss occurs regardless of macronutrient composition. The macronutrient composition recommended by Canadian Guidelines of approximately 55% carbohydrate, 15% protein and 30% or less as fat represents current scientific knowledge for suggested dietary intakes (7).

Many proponents of the very low-carbohydrate diets claim that high dietary carbohydrate intake leads to an overproduction of insulin, and that this causes a metabolic imbalance in obesity. However, scientific evidence does not provide support for this as a causal mechanism. In fact, individuals at risk for insulin resistance are usually recommended a low-fat, high-carbohydrate, high-fibre diet to prevent further weight gain and to reduce the risk of developing heart disease and diabetes. In addition, many of these diets are high in saturated fat and protein, which are concerns for cardiovascular disease and stress on the kidneys respectively. These diets work because they are actually low in calories, not because of their macronutrient composition.

Studies examining varying fat to carbohydrate (CHO) ratios on weight loss

Study 1 (3)	**Study 2** (4)	**Study 3** (5)	**Study 4** (6)
• Overweight sedentary women (n = 35)	• Overweight subjects (n = 62)	• Overweight subjects (n = 68)	• Overweight subjects (n = 43)
• 1200 kcal/d for 10 weeks	• 1550 kcal/d for 12 weeks	• 1200 kcal/d for 12 weeks	• 1000 kcal/d for 6 weeks
• Diets (% fat:CHO): 10:75, 35:45 or 45:25	• Diets (% fat: CHO): 10:70, 32:50* or 32:50*	• Diets (% fat:CHO): 45:25 or 25:45	• Diets (% fat:CHO): 55:15 or 25:45
• Findings: Weight loss was similar with each diet	• Findings: Weight loss was similar with each diet	• Findings: Weight loss was similar with each diet	• Findings: Weight loss was similar with each diet
	**different types of fat*		

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Glycemic Index and Diabetes

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The Canadian Diabetes Association (CDA) recommends that people with diabetes get 50-60% of their energy needs from carbohydrate in cereals, breads, other grain products, legumes, vegetables, fruits, dairy products and added sugars; eat at least 25-35 g of fibre per day; and include foods with a low glycemic index (GI) (1).

GI was developed in the early 1980s to classify the effects of carbohydrate foods on blood glucose levels (2). Today, there are over 750 published GI values for various foods. GI is a clinically tested, standardized system of ranking foods based on their effect on blood glucose levels, over 2-3 hours, compared to a reference food (white bread or glucose, which is given a value of 100). A key determinant of GI of a food is the rate of carbohydrate digestion and absorption. Foods with a low GI are digested and absorbed more slowly than foods with a high GI, resulting in a lower blood glucose response. Foods can be classified as having a low (< 55), intermediate (55 – 70), or high GI (> 70) with glucose as the reference standard (3).

Examples of Low, Intermediate & High GI Foods Within Food Groups*

	LOW	INTERMEDIATE	HIGH
CEREALS	All Bran™ (51)	Frosted Flakes™ (55)	Corn Flakes (81)
FRUITS	Apple (39)	Banana (60)	Watermelon (72)
SWEETENERS	Fructose (14)	Sucrose (60)	Glucose (100)
RICE	Converted (parboiled) (47)	Brown (66)	Instant (87)
POTATOES	Sweet Potato (54)	Baked (60)	Instant Mashed (85)

*Compared to glucose (=100). For GI values using white bread as a reference, see (4). Values adopted from (4).

The concept of GI challenged traditional views that the metabolic effect on blood sugar could be determined by the chemical composition of carbohydrates and that sugars should be avoided in the diabetic diet. It was previously believed that sugars were detrimental for people with diabetes because they caused a rapid and greater increase in blood glucose than starches. However, it was found that some sugars actually have a lower GI than many foods high in starches (see above chart), and that sucrose, in moderate amounts, does not compromise blood glucose levels.

The use of low GI foods has been shown to improve blood glucose and lipid control and is associated with a reduced risk of developing type 2 diabetes. A meta-analysis of 11 studies found that with a low GI diet, glycosylated hemoglobin was reduced by 9%, day-long blood glucose by 16%, cholesterol by 6%, and triglycerides by 9% (5). In addition, some studies have shown that low GI foods may assist in weight management because they elicit a greater satiety effect than do high GI foods and fat.

Along with CDA, the European Association for the Study of Diabetes, Diabetes Australia, and the World Health Organization have recommended the use of GI for people with diabetes. However, the American Diabetes Association (ADA) does not currently endorse its use. Its position is that the total amount of carbohydrate in meals or snacks is more important than the source or type (6). ADA also questions the practicality of using GI, the potential for limiting food choices and the existing clinical evidence supporting its long-term effectiveness. Continued research will help address these concerns and evaluate its usefulness in nutrition education.

Practical Guidelines for People with Diabetes

Proponents of GI recommend that low GI foods be emphasized in the dietary management of diabetes as a method of optimizing blood glucose control (1). This can be accomplished by including at least one low GI food at a meal. Simple substitution of a higher GI food (e.g. banana) with a lower GI food (e.g. orange) will help achieve this. The addition of acidic foods (e.g. vinegar, lemon juice), protein and fat to meals can also slow down the digestion of starch and lower GI. It is important to note that high GI foods do not need to be eliminated from the diet as some contribute both energy and important nutrients. As well, combining high GI foods with low GI foods will equate to an intermediate GI meal. It is essential to eat a variety of foods at all meals and snacks.

Although the GI values were determined on single foods, GI can be applied to mixed meals or whole diets by calculating the weighted GI value of the meal or diet (7). The total carbohydrate content of the meal and the contribution of each food to the total carbohydrate must be known.

It is imperative that GI not be the only criterion by which foods are selected. GI should be used in conjunction with other nutrition recommendations for people with diabetes. Monitoring total carbohydrate intake and distribution of intake are also very important factors to consider. Current clinical and epidemiological evidence supports the use of a high carbohydrate, high fibre, low fat diet for most people with diabetes. Foods with lower GI may have favourable metabolic effects and should be emphasized.

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Carbohydrates and Dental Health

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Oral health is a vital component of overall health and well-being. Yet, dental caries, or tooth decay, is the most common disease of childhood, particularly in minorities and low-income families, and is one of the most preventable diseases in the world (1). Unfortunately, 85% of the world's population does not have access to dental care. Dental caries is characterized by a progressive demineralization of tooth enamel and results from the interaction of four factors in the mouth: cariogenic plaque bacteria, fermentable substrate, host and tooth factors, and saliva (1).

A direct relationship between diet and dental caries is clearly accepted. Typically, the primary focus has been on sugar and dental caries. Although sucrose has cariogenic properties, it is important to understand that all fermentable carbohydrates contribute to dental caries formation. Fermentable carbohydrates include sugars and starches that can be broken down in the mouth by salivary amylase. Starches are broken down by salivary amylase into the disaccharide maltose.

The cavity-producing process starts when food or drinks are ingested and plaque bacteria metabolize the carbohydrate component to form organic acids. These acids lower the pH of the plaque, which can dissolve tooth structure and enamel – leading to dental caries. Thus, all carbohydrate food residues have caries-promoting properties (2). However, sugar alcohols, such as mannitol, xylitol, and sorbitol, which are fermented very slowly and result in limited acid production, do not contribute to tooth decay.

Foods with high cariogenic potential are those with high fermentable carbohydrate content, dissolve slowly or have prolonged oral retention, are eaten frequently, lower plaque pH, and/or adhere to the teeth (1, 2, 4). All fermentable carbohydrates decrease plaque pH and the longer the plaque pH remains acidic, the more likely erosion will occur. Some fermentable carbohydrates maintain a lower pH than others. For example, both corn flakes and a sucrose solution reduce plaque pH, however, acid production persists for a longer period of time with the corn flakes, thereby increasing the potential for demineralization (3).

The form of the carbohydrate food and the frequency of consumption are two factors in caries formation. Foods that stick to the teeth (e.g. caramels, dried fruit) or between the teeth (e.g. potato chips, crackers) are retained in the oral cavity and increase the risk of tooth decay. Retained food particles can remain on the teeth for up to 20 minutes and maltose accumulates rapidly in these food particles. Frequent snacking and consumption of fermentable carbohydrate foods between meals promotes caries production. The 1954 Vipeholm study was one of the first to establish the distinction between the amount of sugar eaten versus the frequency of sugar intake (4). This study demonstrated that dental caries increased dramatically with frequent sugar consumption between meals but had little effect if eaten only during meals.

Just as there are factors that promote dental caries, there are several dietary elements that are protective. Proper salivary flow modifies the effect of the fermentable carbohydrate on the teeth, as it helps reduce the duration of bacteria in the mouth and contains caries-protective components such as fluoride, calcium, magnesium, buffers and anti-microbial agents (5). Proteins and fats also provide protection against dental caries. Protective nutrients, such as fluoride, calcium, vitamin D and phosphorus, help reduce demineralization of tooth enamel. Some foods are also protective against dental caries. For example, eating a piece of hard cheese before a fermentable carbohydrate inhibits the pH drop typically noted after its ingestion. This adds further evidence to the notion that the order in which food is ingested and the specific types of food are related to reducing or enhancing the risk of caries. Thus, moderation and selection of a wide variety of foods remains key to reducing the risk of caries.

A healthy diet is required for dental health (see Table); however, overall oral hygiene is essential. An individual's oral hygiene practice greatly influences the caries forming process. Prevention programs to control and abolish dental caries should focus on fluoridation and proper oral hygiene habits, including brushing, flossing, and regular dental check-ups.

Nutrition Messages for Dental Health

Message	Rationale
Eat a balanced diet representing moderation and variety.	Fermentable carbohydrates can contribute to healthy eating in moderation.
Combine and sequence foods to encourage chewing and saliva production.	Combinations of raw and cooked foods can increase saliva flow. Protein-rich foods combined with cooked carbohydrates and dairy foods combined with fermentable carbohydrates can modify dental plaque pH.
Ensure adequate fluoride intake.	Fluoride increases tooth resistance to acids and promotes remineralization. Good sources include fluoridated water and beverages made with fluoridated water.
Space the frequency of eating or drinking fermentable carbohydrates at least two hours apart.	It may take up to 120 minutes for dental plaque pH to return to neutral after exposure to fermentable carbohydrates.

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Carbohydrates for Refuelling Before and After Exercise

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Total body carbohydrate (CHO) stores are limited, and are often less than the CHO requirements of athletic training and competition. However, the availability of CHO as a substrate for muscle metabolism is a critical factor in the performance of both high-intensity intermittent work and prolonged aerobic exercise. Therefore, sports nutrition guidelines promote a variety of options for acutely increasing CHO availability for exercise, including consuming CHO before, during and in the recovery period between prolonged exercise bouts. When these CHO intake strategies enhance or maintain CHO status, they delay the onset of fatigue, and enhance exercise capacity or endurance.

Prior to competition, an athlete should ensure that liver and muscle glycogen stores are able to support the anticipated fuel needs of the event. For sports events lasting <60 min, muscle glycogen stores that have been normalized to the resting levels of trained athletes are considered adequate. In the absence of muscle damage, muscle glycogen levels can be restored by 24-36 hrs of high CHO intake [7-10 g/kg body mass (BM)/day], in conjunction with a reduction in exercise volume and intensity. Thus, "fuelling up" for most sporting events simply consists of high CHO eating and tapered training on the day before competition.

Athletes who compete in events >90 min may improve their performance by maximizing muscle glycogen stores over the three days prior to their competition via an exercise-diet program known as glycogen (or CHO) loading. Although the original version of CHO loading involved a "depletion" (low CHO) diet prior to this loading phase, recent research shows that trained athletes can increase their muscle glycogen concentrations by 25-100% above resting levels simply by tapering their training and consuming a daily CHO intake of ~ 8-10 g/kg BM over the 72 hrs prior to an event. Such increases in muscle glycogen stores do not benefit short-duration high-intensity exercise or events lasting up to 1 hr. However, "loaded" glycogen stores permit the athlete to continue exercising at their optimal pace for a longer time during prolonged events involving exercise of moderate intensity (e.g. cycling, running) or intermittent nature (e.g. team games). Finally, performance can be enhanced by the consumption of a CHO-rich meal in the hours prior to exercise via a further increase in liver or muscle glycogen stores, or by providing a source of glucose for ongoing release by the gut during exercise.

Post-exercise refuelling is a challenge for athletes who undertake more than one training session or event each day. While the main dietary factor influencing glycogen synthesis is the amount of CHO consumed, there is some evidence that moderate and high glycemic index (GI) CHO-rich foods and drinks may be more favourable for glycogen storage than some low GI food choices.

Glycogen storage may occur at a slightly faster rate during the first couple of hours after exercise, however the main reason for promoting CHO-rich meals or snacks soon after exercise is that effective refuelling does not start until ~ 1g/kg BM CHO is consumed. This strategy is important when there is less than 8 hrs between exercise sessions but when recovery time is longer, the athlete should choose their preferred meal schedule for achieving total CHO intake goals. Whereas earlier research indicated that co-ingestion of protein with CHO may enhance glycogen synthesis, these findings have been refuted in recent studies. Nevertheless, the provision of protein and other nutrients in post-exercise meals and snacks may be useful in enhancing the progress of other processes of recovery and adaptation to exercise.

Practical guidelines for post-exercise recovery

- When athletes need to maximize recovery in preparation for another workout/event within 6-8 hrs, refuelling should begin as soon as possible (i.e. within 30 min) with the intake of a substantial amount of CHO-rich food and drinks (at least 1 g/kg BM).
- Although individual needs for CHO and energy vary between athletes, CHO refuelling targets are generally set at ~ 1 g/kg BM for each 2 hours of recovery, towards a daily target of ~ 7-10 g/kg BM. A meal pattern that suits the athlete's timetable and gastrointestinal comfort should be selected.
- Evidence suggests that CHO-rich foods and drinks with a moderate or high GI are better suited to glycogen restoration than foods with a low GI. Athletes should choose a variety of nutrient-rich foods to meet their CHO intake targets to ensure that their total nutritional goals are met.
- Intake of protein and micronutrients in the early phases of post-exercise recovery may be useful in promoting other processes of repair and adaptation.
- Restoration of fluid balance is another key issue of post-exercise recovery.

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Consumer Knowledge of Carbohydrates

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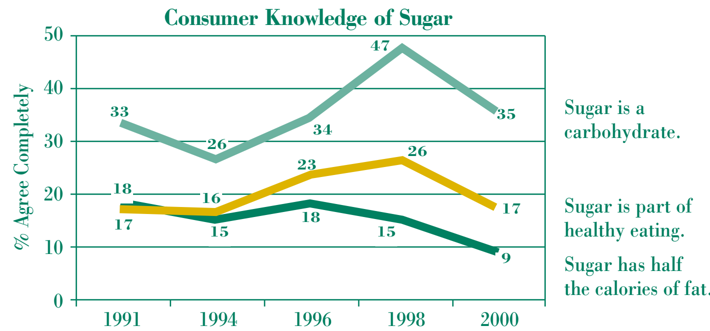
Scientists and health professionals are in general agreement that a variety of carbohydrates should make up the greatest proportion of a healthy diet and that sugars do not cause lifestyle related diseases. This is in sharp contrast to the messages consumers most frequently hear, such as those touting the benefits of low carbohydrate diets. Not surprisingly, consumer research demonstrates that the majority of Canadians have a poor understanding of carbohydrates and their relation to health.

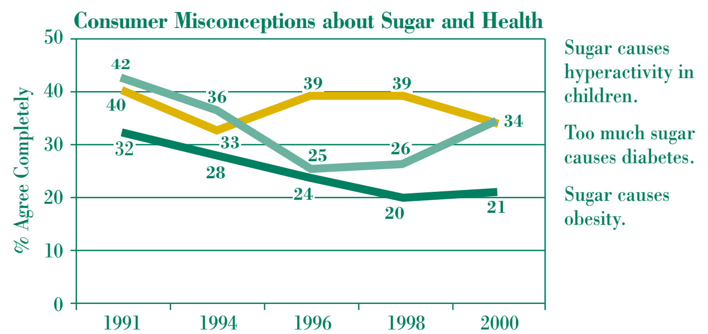
Canada's national nutrition recommendations advise Canadians to consume more carbohydrates from a variety of sources. The increase should come from foods rich in starch and fibre and there is no recommendation to change sugars intake. The stated benefits are to help reduce fat intake and to lower the risk of chronic disease, notably heart disease and certain cancers. The most recent international expert consensus report on carbohydrates reinforces these recommendations, concluding that an optimum diet should contain "at least 55% of energy from a variety of carbohydrate sources" (1). With respect to carbohydrate components, the report concludes "that the bulk of carbohydrate-containing foods consumed be those rich in non-starch polysaccharides and with a low glycemic index" and that "there is no evidence of a direct involvement of sucrose, other sugars and starch in the etiology of lifestyle related diseases." Such scientific evidence has been translated into dietary guidance for consumers. The FAO/WHO Food-Based Dietary Guidelines (2) and Canada's Food Guide emphasize cereals, breads, other grains, vegetables and fruit and acknowledge that moderate intakes of sugar are compatible with a varied and nutritious diet.

Unfortunately, despite efforts of scientists and nutritionists to communicate sound dietary guidance, consumer research indicates that Canadian understanding of these messages is limited. Available studies demonstrate that, in contrast to concerns about decreasing fat, relatively few Canadians are concerned about increasing consumption of carbohydrates and that most Canadians have a poor understanding of carbohydrate components (starch, fibre, sugar).

Canada's National Population Health Survey (4) found that 59% of Canadians were trying to decrease their consumption of fat, whereas only 26% were attempting to increase their starch and fibre intake. In another study (5), more than half of the people surveyed wanted to reduce their intake of fat (73%), cholesterol (62%), saturated fat (60%), sugars (56%) and calories (55%), while only 16% were trying to increase their carbohydrate intake and 22% were trying to decrease carbohydrate.

Results from a biennial national tracking survey conducted for the Canadian Sugar Institute (3) show that Canadians generally have a poor understanding of sugar in relation to nutrition and health. In 2000, only a small percentage of people agreed completely with the statements that sugar is a carbohydrate (35%), is part of healthy eating (17%) and has half the calories of fat (9%). Moreover, the proportion of people who agree with these statements has declined since 1998 (47%, 26% and 15% respectively). Furthermore, contrary to scientific evidence, a large proportion of consumers agree completely that sugar causes hyperactivity (34%), diabetes (34%) and obesity (21%). See figures below for more detail.





The lack of understanding of the link between carbohydrates and health is also reflected in the information that consumers seek on food labels. Despite the importance of high total carbohydrate and fibre to a healthy diet, only 3% want label information on total carbohydrate and 2% fibre compared to 46% fat, 16% calories and 11% sugar (5). Among those with diabetes, a much more pronounced focus on sugar is evident. Even though diabetes guidelines emphasize control of body weight and total carbohydrate, rather than sugar intake (6), 29% of people with diabetes wanted to know the sugar content in foods, while only 12% wanted information about calories, 2% about carbohydrate and 0% about fibre.

One reason why Canadians poorly understand carbohydrates may be related to the sources from which they obtain nutrition information. Of 15 categories, the top sources of nutrition information are food labels, radio/TV, friends/relatives, magazines, food ads, books and newspapers (7). Physicians rank eighth and dietitians/nutritionists rank 14th. Thus, consumer awareness and interpretation of nutrition messages about carbohydrates may not be consistent with current science and dietary guidance. Information in popular diet books, touting the benefits of low carbohydrate diets and focusing on the exclusion of individual nutrients, such as sugar, likely contribute to this misunderstanding. There is clearly a significant challenge ahead in finding simple, understandable nutrition messages about carbohydrates that can reach consumers and lead to healthier diets.

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Barriers to Change

Findings from the Ontario Food Survey

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The Ontario Food Survey (OFS) is one of many provincial surveys being undertaken. To date, three other provinces have completed nutrition surveys – Nova Scotia, Quebec and Saskatchewan. The OFS was a joint project of Ryerson University, University of Toronto – Program in Food Safety, Heart & Stroke Foundation of Ontario, Ontario Ministry of Health and Health Canada. Although the survey was conducted in 1997-98, the data are currently in the process of being analyzed. The purpose of the survey was to collect information about nutrient and food intakes and dietary consumption patterns of adult Ontarians. There were several other secondary health and food related components to the survey. The study design was based on in-home interviews by trained interviewers, consisting of a 24-hour dietary recall, food frequency questionnaire, anthropometric measurements, demographic questionnaire, and a general health questionnaire. Of the original random sample of 6,284 subjects, only 2,881 individuals could be contacted to participate in the survey. Of these, 1,189 (41%) participated.

One component of the survey analyzed the desire to modify food intakes and the barriers to making these changes. The object was to examine the link between food intake and nutrition recommendations and identify the factors shaping food choices. The respondents were asked whether they wanted to increase, decrease, or maintain current intake levels of foods from seven food groups (see Table for groups). If the respondents indicated a desire to change intake, they were asked to identify any reasons inhibiting change. Their responses were categorized into eight barriers: information/knowledge, preparation, preference, availability, cost, health, habit, or other.

With the exception of fruits/vegetables/juices, the majority of respondents indicated that they would like to maintain current intake levels of the specified food groups (Table). The respondents indicated three main reasons for maintaining current intake levels: "I already eat well" (73.6%), "I do not want to make any changes" (12.9%) and "I have already made changes" (10.6%). In general, more men than women were satisfied with their current intake levels. The food groups the respondents wanted to increase the most were fruits/vegetables/juices and meat alternates. Interestingly, while Canada's Nutrition Recommendations emphasizes the need to increase carbohydrate-rich foods, the respondents had relatively low interest in increasing breads/rice/cereals/grains.

Desire to increase, decrease, or maintain current intake: males vs. females

	Increase (%)		Decrease (%)		Maintain (%)	
	Men	Women	Men	Women	Men	Women
Fruits/vegetables/juices	52	62	2	1	46	37
Meat Alternates	23	37	3	2	74	61
Milk and Dairy Products	16	32	10	8	74	60
Breads/rice/cereal/grains	12	19	11	16	75	65
Meats/fish poultry/eggs	16	15	14	18	70	67
Sweets/sugars/soft drinks	6	5	29	38	65	57
Oils/margarine/butter	5	1	24	30	74	69

Overall, the three main barriers to changing food intake were preference, habit and preparation. Specifically, the most frequent response for not increasing current intake was habit whereas the prime reason for not decreasing current intake was preference. Of interest, health, cost and knowledge were minimal factors related to changing dietary patterns.

The OFS provides useful information on individual perception of current intake and barriers to changing food intake. Health professionals may need to address the desire to maintain current intakes when studies have indicated that people are consuming inadequate servings of certain food groups. As well, nutrition education programs can be designed to target the major barriers to changing food intake. This information provides insight into the rationale for individual food intake and consumption habits and demonstrates that the power of preference is still a main contender in food choice selection.

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Nutrition Information Service

Carbohydrate News is an annual health professional publication of the Canadian Sugar Institute (CSI), *Nutrition Information Service*. The *Nutrition Information Service* is managed by Registered Dietitians and Nutrition Researchers, and guided by our Scientific Advisory Council, providing current scientific information on carbohydrate, sugar, and health.

Acknowledgements
CSI thanks Gérald Fortier for the French translation and Nathalie Jobin, PhD, Dt.p for her review of the French translation of *Carbohydrate News*.

Publié en français sous le titre : «Glucides-Info»

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