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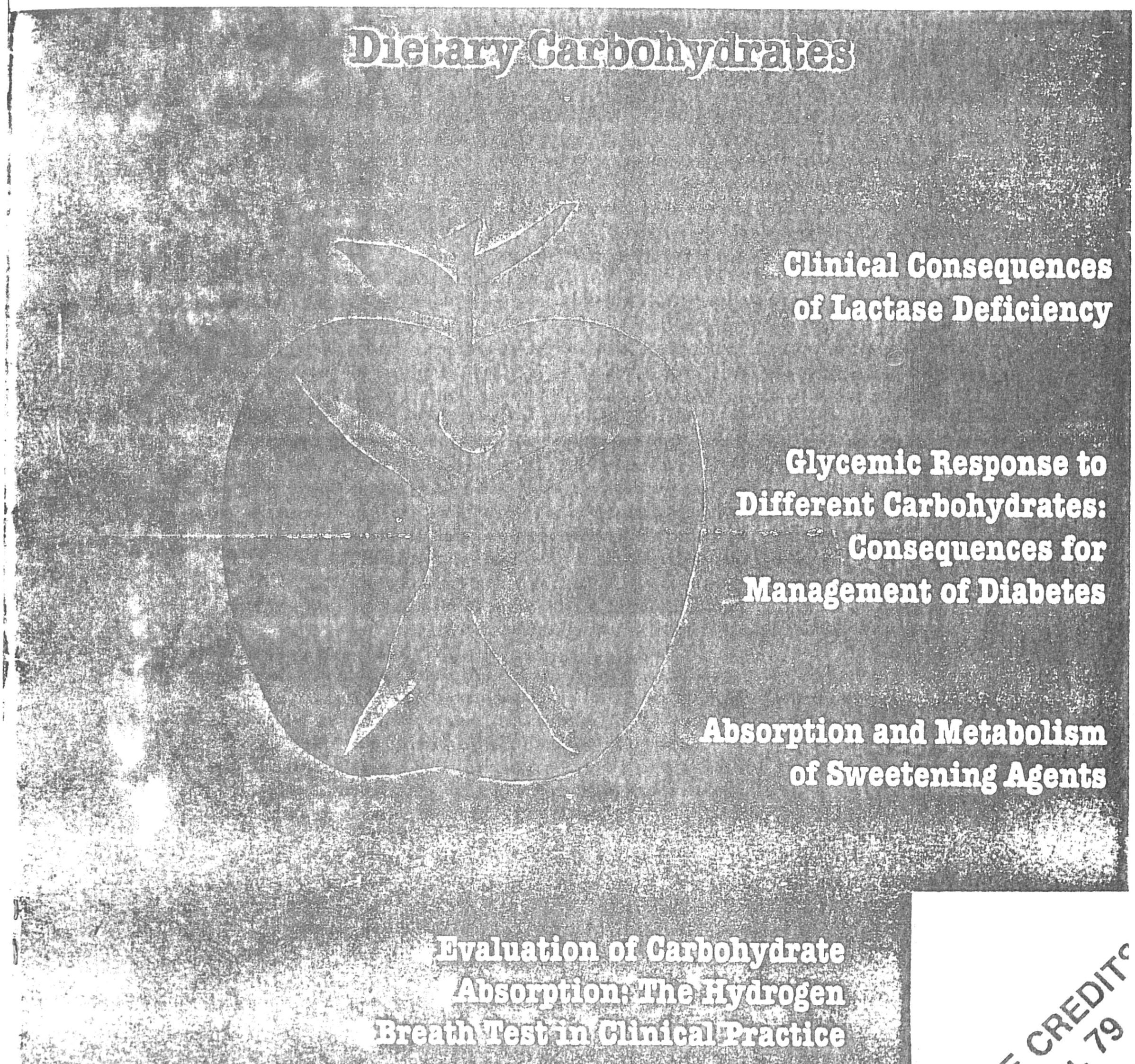

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About This Issue . . .

Dietary Carbohydrates: Newer Clinical Implications

Carbohydrates are an important issue in human dietetics. The principal action of plant photosynthesis—the primary source of metabolizable energy for all earthly life forms—is to convert water and carbon dioxide into carbohydrate.[1] Plants convert carbohydrates both into structural entities (e.g., cellulose) and into storage forms of energy (e.g., starch). Mammalian metabolism has been adapted to use carbohydrate as its principal source of fuel by way of the oxidation of glucose to form high-energy phosphate bonds. The regulation of glucose homeostasis is the major task of a series of endocrine hormonal responses, exemplified by—but not limited to—the secretion of insulin by the beta cells of the pancreatic islets of Langerhans.

In humans, carbohydrates must be absorbed as simple sugars, mainly as glucose, galactose, or fructose. An array of digestive enzymes, both secreted (amylase) and membrane-bound (sucrase/isomaltase; maltase; lactase), have been developed to reduce the more complex, natural sources of food carbohydrates into these elemental, monosaccharide sugars. The rate at which simple sugars are liberated in the intestine governs their rate of intestinal uptake; their rate of intestinal uptake, in turn, conditions the hormonal responses of glucose homeostasis.

Not all dietary carbohydrate, however, is accessible to digestion by human enzymes. Mammalian milk contains lactose, which requires a specific hydrolase, lactase, to split the dissacharide into its constituent monosaccharides; glucose and galactose. Before the modern era, the only relevant source of food for infants was breast milk; and the infantile intestine has abundant amounts of lactase. However, the persistence of this enzyme beyond the weaning period was of no nutritional advantage until after the domestication of dairy animals. Domestication of livestock provided sources of non-human milk as food for the community; today, the ability to digest milk sugar during adult life conveys certain nutritional advantages where milk is available. However, even today, most of the world's population manifests a steady involution of their intestinal lactase activity in childhood and early adolescence.[2]

In yet another historical context, paleodietetic studies (examination of fossilized stools of early Homo sapiens) suggest that the hunter-gatherers of prehistory had a diet that included seeds, roots, leaves, nuts, and fibrous fruits in such abundance that daily intakes of indigestible residue were on the order of 100 to 300 g. The advent of agriculture and milling, however, has produced a refined diet in contemporary Western industrialized countries that affords less than 5 to 10 g of dietary fiber daily. The consequences of this dramatic reduction in fiber intake has been the source of much speculation[3] and the incentive for much recent research.

Recently, we have also come to appreciate that not all of the complex carbohydrate that escapes digestion in the small intestine is lost to the energy economy of the organism. Enzymes in the normal bacterial flora of the human colon are capable of digesting some or all of the bonds of the plant residue that reaches the large intestine. Anaerobic microbes then ferment the liberated sugars, giving

rise to gases, such as hydrogen and methane, and smaller organic units, such as short-chain, volatile fatty acids. These latter molecules are potential sources of energy for the human body. It has now been shown that a high percentage of the fatty acid byproducts of colonic fermentation are conserved by the colon, are absorbed, and serve to provide fuel for the body.[4–6] This absorption also serves to limit the potential for nonabsorbed carbohydrates to produce diarrhea.[5]

The progressive changes in man's diet throughout history have influenced the form of carbohydrate that predominates in the diet. Today, 40–50% of dietary carbohydrate in the U.S. is in the form of sugars. This has conferred on the public an appreciation, if not a craving, for sweetness in the foods they eat. Attempts to provide sweeteners for the diet have included modifications of natural products and substitution of artificial agents by the food and beverage industries. Some of the changes seem to provide interesting problems in both public health and the practice of medicine and pediatrics.

In this issue, Drs. Newcomer and McGill discuss the issue of lactose digestion and its relevance to those individuals who lack a robust complement of intestinal lactase. This condition has profound implications in the light of our increased consciousness of dietary calcium intake and bone mineralization. Dr. Anderson discusses the consequences of our present mix of dietary carbohydrates in terms of the hormonal response to monosaccharide absorption and its primary derangement, diabetes mellitus. The chemical form of digestible carbohydrates and the quantity and quality of undigestible carbohydrates can now be exploited in ways that improve the overall glucose tolerance of both diabetics and nondiabetics alike.

Not all sweeteners are readily absorbable, and not all absorbable sweeteners are carbohydrates. The effects of the new mix of natural and artificial sweeteners in our diet on the occurrence of gastrointestinal intolerance or the alteration of nutrient metabolism are reviewed in Dr. Caballero's contribution. Finally, the diagnosis of carbohydrate malabsorption in patients and populations is essential to the understanding of dietary problems. The use of the hydrogen breath-analysis test as a diagnostic procedure in investigative medicine and clinical practice is the subject of the final article in this issue.

The relief of symptoms and disabilities and the prevention of morbidity are major tasks of practitioners and public health personnel. The papers in this issue of Clinical Nutrition should yield insights into the ways that diet and its carbohydrate content may influence the health, comfort, and longevity of the public.

—Noel W. Solomons

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