Plant Fiber Intake in the Pediatric Diet

Dietary fiber has been defined as the part of material in foods impervious to the degradative enzymes of the human digestive tract. The dietary fiber of plants is comprised of carbohydrate compounds including cellulose, hemicellulose, pectin, gums, mucilages, and a noncarbohydrate substance, lignin. These substances, which form the structure of plants, are present in the cell walls of all parts including the leaf, stem, root, and seed. Animal tissue also contains indigestible substances.

Crude fiber and dietary fiber are not the same thing. Crude fiber refers to the residue left after strong acid and base hydrolysis of plant material. This process dissolves the pectin, gums, mucilages, and most of the hemicellulose and mainly is a measure of the cellulose and lignin content. Clearly, this method tends to underestimate the total amount of fiber in the food. Most food composition tables give only crude fiber values.

Current interest in fiber was stimulated by the suggestion that it might help to prevent certain diseases common in the United States, namely diverticular disease, cancer of the colon, irritable bowel syndrome, obesity, and coronary heart disease. African blacks in rural areas where the fiber intake was high rarely had these diseases; however, during the past 20 years as this population moved to the cities and adopted Western habits (including a Western diet), they began to suffer from the same "Western-type" diseases.

A high-fiber diet increases fecal bulk, produces softer, more frequent stools, and decreases transit time through the intestine. These factors may be responsible for the supposed beneficial effects of fiber. A decreased transit time implies less time for potential carcinogens to be in contact with the intestinal mucosa. The increased bulk would dilute potential carcinogens and produce less straining at stool, a factor implicated by Burkitt and co-workers in the development of diverticulosis.

Obesity is rare in populations eating most carbohydrates as complex carbohydrates, such as rice, beans, lentils, and cereal grains, which contain large amounts of fiber. This could simply be that the increased mastication required for these foods slows caloric ingestion or that the increased bulk accelerates satiety. However, it could also be caused by a lower caloric intake.

Arteriosclerosis and coronary heart disease may also be inversely related to low fiber intake. Trowell suggests that a high fiber intake lowers blood cholesterol by increasing the fecal excretion of bile acids and sterols which are metabolites of cholesterol in man. Human studies have confirmed this. Subjects consuming from 12 to 36 gm of pectin daily for several weeks have shown a significant reduction of total serum cholesterol ranging from 8% to 30%.

The different fractions of fiber have different physiologic effects. Pectin has a cholesterol-lowering effect which may be caused by bile acid sequestration and increased stool-fat content. Lignin has bile acid-binding properties in vitro, but these have not yet been demonstrated in vivo. There are conflicting data about whether it lowers serum cholesterol. Cellulose has been shown to increase output of fecal bile acid. It is not thought to have a hypcholesterolemic effect, although this is questionable. Hemicellulose increases fecal excretion of bile acid, but probably by a mechanism other than adsorption. There is some evidence that it has a hypcholesterolemic effect.

Most evidence for the beneficial effects of fiber is epidemiologic and refers almost entirely to adults, and the diseases mentioned (with the exception of obesity) require years to develop. In addition to fiber intake, there are many variables in the populations studied, such as intake of saturated fats and sucrose, exercise, and stress, all of which are implicated as causative factors in these diseases.

Should a recommendation be made for an in-
creased fiber intake in children? An increase in fiber
means an increase in the consumption of fruits,
vegetables, legumes, and whole grain cereals and
breads. Although survey data are limited, there are
some indicators that current intakes of fiber in
children are low. In a 2,000-household survey con-
ducted in 1975, the findings were expressed in terms
of the number of servings of the four basic food
groups suggested by the United States Department
of Agriculture (USDA).\(^8\) Seventy-five percent of the
children ate less than the recommended daily
amounts of fruits and vegetables, and 62% of them
ate less than the recommended amount of bread
and cereals.\(^8\) HANES (Health and Nutrition Ex-
amination Survey) data (C. M. Dresser, J. Habicht,
unpublished data, 1977) show that approximately
35% to 50% of children eat one or fewer fruits or
vegetables rich in vitamin C per day, that 30% to
40% of children 1 to 5 years old have vitamin C
intakes less than two thirds of the recommended
daily allowance (RDA), and roughly 20% of them
have vitamin A intakes below two thirds of the
RDA.\(^9\) Fruits and vegetables (chiefly the deep or-
age, yellow, and green ones) are important sources
of carotenoids, which are precursors of vitamin A.
Therefore, in terms of dietary recommendations for
nutrients, and without even considering fiber, large
numbers of children have low intakes of fiber-con-
taining foods.

Several objections to an increased fiber intake for
children have been made. The first is that children
have a small stomach capacity and the caloric den-
sity of high-fiber foods is low; therefore, children
would be unable to ingest adequate calories. This
could be a problem in highly restricted vegetarians,
although it could be solved easily by including nuts
and legumes (which are relatively high in both
protein and fat) in the diet.

The second objection is that dietary fiber may
influence adversely the absorption of certain essen-
tial minerals such as calcium, iron, copper, magnesi-
urn, phosphorus, and zinc. One advantage of white
flour is that the removal of the husk (bran) means
much of the phytate (inositol hexaphosphate) is
removed. These minerals may form insoluble com-
pounds with phytate that render them unavailable.
If the intake of these minerals is low, and the small
amount consumed is chelated, a deficiency state
may be produced. This may be a serious problem in
developing countries if the main source of zinc is
bread. For example, in the rural populations in Iran
where zinc deficiency occurs, unleavened whole

| TABLE 1. Guide to Usual Food Patterns for Children Aged 1 to 10 Years* |
|---|---|---|
| Food | Foods Included | Serving Size | 1-3 yr | 4-6 yr | 7-10 yr |
| Cereal and bread | Whole grain or enriched and iron-fortified cereals (cooked or ready-to-eat); breads, rolls, muffins; noodles, spaghetti, macaroni, rice; cornmeal, oatmeal, farina, rolled wheat | 1 slice bread | 4 small (half-sized) servings | 4 servings or more | 4 servings or more |
| | | 1 oz (¼-1 cup) ready-to-eat cereal | | | |
| | | ½ cup cooked cereal or pasta | | | |
| | | Varies | | | |
| Fruits | All fruits (fresh, frozen, or canned) and juices. Good sources of vitamin C are citrus fruits (eg, oranges, grapefruit, tangerines), cantaloupe, strawberries (see also vegetables). Include at least one good source of vitamin C per day | 2 servings or more; fruits with pits not advised this age group | 2 servings or more | 2 servings or more | 2 servings or more |
| Vegetables | All vegetables (fresh, frozen, or canned) and potatoes. Good sources of vitamin C are cabbage, tomatoes, green peppers, white potatoes. Good sources of vitamin A are carrots, yams, sweet potatoes, winter squash, green leafy vegetables, tomatoes. Include one good source of vitamin A at least every other day | 1-3 yr: ¼ cup | 2 servings or more | 2 servings or more | 2 servings or more |
| | | 4-6 yr: ¼ cup | | | |
| | | 7-10 yr: ½ cup | | | |

grain bread accounts for approximately 75% of the energy intake.\textsuperscript{10} It is unclear, however, how relevant this observation is to the United States where bread and cereals account for approximately 20% of the zinc intake and the intake of animal protein is high.\textsuperscript{10} Also, the phytate in whole wheat can be destroyed by yeast fermentation, and bread in this country is generally made with yeast.\textsuperscript{1} Although it is believed that mineral deficiencies are unlikely to develop in children on typical Western diets, even with a reasonable increase in their dietary fiber intake,\textsuperscript{12} there is little direct evidence to support this. However, limited results from metabolic work suggest that moderate amounts of dietary fiber do not significantly affect mineral status. A study was done in 1943 on children 4 to 12 years old who consumed from 4 to 6 gm of crude fiber (cellulose and hemicellulose) per day for periods ranging from 30 to 225 successive days.\textsuperscript{13} The authors report that no nitrogen or mineral balance studies were actually conducted on the children, this conclusion may not be valid. Based on fecal analysis, the older children also seemed to have an increased ability to decompose cellulose and hemicellulose.

A more recent, rigorously conducted study investigated the effect of three fibers (hemicellulose, cellulose, and pectin) at a level of 14.2 gm/day on copper, zinc, and magnesium utilization by adolescent boys.\textsuperscript{14} Some alteration in mineral utilization was found. Hemicellulose supplementation resulted in significantly increased fecal zinc, copper, and magnesium excretions and significantly lowered zinc, copper, and magnesium retentions. Cellulose had a directionally similar approach, but to a lesser degree. Pectin had the least influence on mineral utilization and retention. This corresponded primarily to losses of these minerals in the feces. Serum levels of zinc, copper, and magnesium were resistant to change. However, each fiber was consumed for only four days, and longer periods may be required before serum changes are detected.

More work needs to be done in this area before any firm recommendations can be made. It is not known whether an increased fiber intake during pregnancy would have any effect on the fetus and

<table>
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<th>TABLE 2. Fiber Content of Foods (per 100 gm)*</th>
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newborn infant in terms of vitamin and mineral status, nor is it known what effect the fiber intake of nursing mothers has on the mineral composition of their milk.

Nevertheless, a substantial amount of fiber probably should be eaten to ensure normal laxation. Fiber is probably not needed in infants less than 1 year old. With introduction of solid foods into the diet of the older child, care should be taken to include whole grain cereals, breads, fruits, and vegetables. However, a diet that places emphasis on high-fiber, low-calorie foods, to the exclusion of the other common food groups, would not be recommended for children. Tables 1 and 2 give the fiber content of foods commonly consumed and portions that should be eaten by children.

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