

Dietary Fiber and Human Health

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INTRODUCTION

In the past quarter century, dietary fiber has emerged as a leading dietary component in chronic disease prevention. High fiber intake lowers risk for cardiovascular disease (Kromhout et al., 1982), some cancers (Kromhout, 1982a), hypertension (Anderson, 1983a), diabetes (Anderson, 1986) and obesity (Anderson and Bryant, 1986a). In addition, dietary fiber has therapeutic value in treatment of coronary heart disease (CHD) (Arntzenius et al., 1985), hyperlipidemia (Anderson and Tietjen-Clark, 1986), hypertension (Anderson, 1983), diabetes (Anderson and Bryant, 1986b), obesity (Anderson and Bryant, 1986c), and gastrointestinal diseases (Anderson, 1985a). An overwhelming consensus recommendation now advises an intake of five to six servings of vegetables and fruits daily (National Academy of Sciences, 1989; U.S. Dept. of Health and Human Services, 1988a), for a dietary fiber intake of 20 to 35 g/day or 10 to 13 g/1000 kcal for healthy adults (Pilch, 1987a).

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In its recent report "Diet and Health", the National Academy of Sciences (1989) concluded that "Epidemiologic and clinical studies indicate that a diet characterized by high-fiber foods may be associated with a lower risk of coronary heart disease, colon cancer, diabetes mellitus, diverticulosis, hypertension, or gallstone formation, but there is no conclusive evidence that it is dietary fiber rather than the other components of vegetables, fruits, and cereal products, that reduces the risk of those diseases."

Table 1 lists the 10 leading causes of death in the United States for 1987 (U.S. Dept. of Health and Human Services, 1988b). Cardiovascular disease (heart disease, strokes, and atherosclerosis), cancer, and diabetes account for 61% of these deaths. Dietary practices, including dietary fiber intake, affect development of all of these diseases and hold the potential to reduce premature death from these causes. This report reviews the characteristics of dietary fiber; the protective value of a vegetarian lifestyle; the health benefits of dietary fiber; the relationships between dietary fiber and diabetes, hypercholesterolemia, hypertension, and obesity; and outlines practical implications of dietary fiber intake. Preference is given to providing a comprehensive list of relevant references rather than discussing a few selected references.

Table 1. Estimated total deaths and contributing factors for the 10 leading causes of death in the United States, 1987.^z

Rank	Cause of death	Contributing factors ^y	Number	Percent of total deaths
1	Heart diseases	D,E,L,F	759,000	35.7
2	Cancers	D,L,F	476,700	22.4
3	Strokes	D,E,L,F	148,700	7.0
4	Unintentional injuries	L	92,500	4.4
5	Chronic obstructive lung diseases	L	78,000	3.7
6	Pneumonia and influenza	L	68,600	3.2
7	Diabetes mellitus	D,E,F	37,800	1.8
8	Chronic liver diseases	L	29,600	1.4
9	Chronic liver diseases and cirrhosis	L	26,000	1.2
10	Atherosclerosis	D,E,L,F	23,100	1.1
	All causes		2,125,100	100

^zAdapted from the Surgeon General's report on Nutrition and Health (1988) and Anderson et al. (1990).

^yD = diet. E = exercise, L = lifestyle, and F = fiber.

CHARACTERISTICS OF DIETARY FIBER

Dietary fiber can be defined as the endogenous components of plant materials in the diet that are resistant to digestion by human enzymes (Pilch, 1987b). Dietary fibers are predominantly cell wall components that include nonstarch polysaccharides and lignin. These fibers can be classified, simplistically, as water-soluble and water-insoluble. The soluble fibers include pectins, gums, and mucilages, while the insoluble fibers include cellulose, most hemicellulose (or noncellulosic polysaccharides) and lignin (Anderson, 1985b).

Physiologic and clinical effects of soluble and insoluble fiber differ. Soluble fibers tend to delay gastric emptying, slow passage of food through the small intestine, and have little effect on fecal bulk. Insoluble fibers tend to hasten passage of food through the intestine and increase fecal bulk. Most soluble fibers lower serum cholesterol and decrease the glycemic response to food. In contrast, insoluble fibers usually do not lower serum cholesterol, but have important clinical effects on bowel regularity and fecal bulk. Mixtures of both soluble and insoluble fibers may have the greatest therapeutic effects in diabetes and hypertriglyceridemia (Anderson, 1985c).

HEALTH BENEFITS OF A VEGETARIAN LIFESTYLE

Vegetarian dietary habits are associated with several health benefits. Vegetarian individuals, on average, are leaner and have healthier lifestyles than nonvegetarian individuals (Sacks et al., 1975a; Walden et al., 1964; Nieman et al., 1989). Their all-cause mortality is significantly lower than age- and gender-matched nonvegetarian individuals (Lemon and Walden, 1966; Kahn et al., 1984a), and this can be related to lower mortality rates from coronary heart disease (Wynder et al., 1959a; Hickie and Ruys, 1976a; Kristein, et al., 1977) and cancer (Wynder, 1959b. Lemon and Walden, 1966; Phillips, 1978).

Serum total cholesterol and low-density lipoprotein (LDL) cholesterol, and total to high-density lipoprotein (HDL) cholesterol ratios are lower in vegetarian than in nonvegetarian control subjects (Hardinge and Stare, 1954; Hardinge et al., 1958; Walden, 1964b; West and Hayes, 1968; Sacks, 1975b; Hickie and Ruys 1976b; Burslem et al., 1978; Webster and Rawson, 1979a; Knuiman and West, 1982; Cooper et al., 1982; Abdulla et al., 1984; Masarei et al., 1984a; Fisher et al., 1986; Sacks et al., 1986; Thorogood et al.,

1987; Nieman et al., 1989b). Serum total and LDL-cholesterol levels are associated with increased risk for CHD, while serum HDL-cholesterol levels protect against CHD.

Vegetarian individuals usually also have lower systolic and diastolic blood pressures than nonvegetarians (Malhoua, 1970; Sacks et al., 1974b; Anholm, 1975; Armstrong et al., 1977; Webster and Rawson, 1979b; Haines et al., 1980; Trowell, 1981; Rouse et al., 1983; Beilin et al., 1987; Ophir et al., 1983). Dietary sodium, potassium, calcium, magnesium, carbohydrate, fatty acids (saturated, monounsaturated, and polyunsaturated, as well as omega-3 or omega-6 types) and dietary fiber are among the dietary factors that could contribute to blood pressure differences between vegetarians and nonvegetarians (Rouse et al., 1986a). The specific effects of dietary fiber on serum lipids and blood pressure are reviewed below.

HEALTH BENEFITS OF DIETARY FIBER

The health benefits of dietary fiber intake have been recognized since Old Testament times of the Bible (Burkitt, 1987; Kritchevsky, 1988). Pioneering work of Walker (1947), Cleave (1956), Burkitt (1969), and Trowell and Burkitt (1981) and Trowell (Trowell, 1975) linked low dietary fiber intake to a number of Western diseases. More recently, careful epidemiologic studies (Morris et al., 1977a; Liu et al., 1982a; Khaw and Barrett-Connor, 1987a; Kromhout et al., 1982b) established the association between high levels of dietary fiber intake and low Prevalence rates of CHD and cancer. Because the links between dietary fiber and CHD appear strongest, these reports will be reviewed here.

Epidemiologic data from a variety of studies suggest that dietary fiber may protect from CHD. Dietary fiber may decrease risk of CHD by decreasing serum lipids, lowering blood pressure, improving glucose metabolism while decreasing serum insulin, and assisting in weight maintenance (Anderson, 1985d). Dietary fiber also may protect against CHD through other mechanisms. The protective effect of dietary fiber is independent of serum cholesterol levels (Morris et al., 1977b. Liu et al., 1982b).

Morris and Man (1977) reported that the high dietary fiber intakes of bank and transport workers in London were protective from CHD, independent of other dietary and cardiovascular risk factors. Subsequently, Kromhout et al. (1982) reported that mortality from CHD was ≈ 4 -fold higher in Dutch males with low fiber intakes than in males with high fiber intakes (Fig. 1). This effect also was independent of other dietary variables and remained significant after

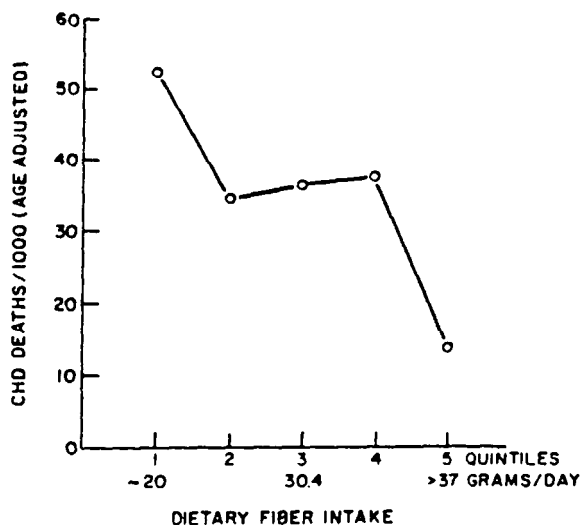


Fig. 1. Mortality from chronic heart disease (CHD) in males in The Netherlands.

multivariate adjustment for other risk factors. This study suggested that including 37 g of dietary fiber daily may protect from CHD.

Using data from 20 economically advantaged countries, Liu et al. (1982) estimated that dietary fiber intake was inversely related to CHD mortality rates. Khaw et al. (1987) reported that a 6-g increase in dietary fiber intake was associated with a 25% reduction in CHD mortality ($P < 0.01$) independent of other dietary variables, including calorie, fat, cholesterol, protein, carbohydrate, or alcohol intakes. After multivariate adjustment for age, gender, plasma cholesterol, fasting plasma glucose, blood pressure, obesity, and cigarette smoking habit, the protective effect was still statistically significant.

Vegetarians illustrate the possible protective role of fiber, because vegetarians have higher fiber intakes (Kritchevsky et al., 1984) and a lower risk for CHD than nonvegetarians (Kahn et al., 1984b; Phillips et al., 1978).

In Great Britain, Burr et al. (1982) reported that 10,943 vegetarians were at lower risk for CHD, but that increased dietary fiber intake alone could not account for this decreased risk.

Other studies also demonstrated an association between higher dietary fiber intakes and lower risk for CHD, including the Baltimore Heart Study (Hallfrisch et al., 1988) and the Irish-Boston Diet-Heart Study (Kushi et al., 1986). Three other studies (Gordon et al., 1981a; Garcia-Palmieri et al., 1980; McGee et al., 1984) did not report dietary fiber intake, but noted an inverse relationship between dietary carbohydrate intake and CHD: carbohydrate may have served as a surrogate measure for dietary fiber in some of these studies (Gordon et al., 1981b).

The Oslo study (Hjerman, 1987) suggests that dietary change plays a significant role in primary prevention of CHD. The intervention group in the study ate more vegetables and fish and less fat than the control group. They also had a 47% lower incidence of CHD over a 5-year period. The dietary intervention group ate ≈ 30 to 42 g of fiber daily, compared to ≈ 22 to 30.8 g daily for the control group.

Collectively these studies indicate that dietary fiber may provide protection from CHD both through modifying CHD risk factors and through other mechanisms. A dietary fiber intake of 37 g/day may be a protective level (Kromhout, 1982c), while an increase in dietary fiber intake of 6 g/day may reduce risk for CHD by 25% (Khaw and Barrett-Connor, 1987b).

DIETARY FIBER AND DIABETES

Diabetic individuals gain both specific and general health benefits by increasing their dietary fiber intake. The specific benefits include decreased insulin requirements or increased insulin sensitivity,

improved blood glucose control, and reduced frequency of hypoglycemic episodes. The general benefits include decreased serum cholesterol and triglycerides, lower blood pressure, improved bowel function, and assistance in weight management (Anderson and Bryant, 1986d; Anderson et al., 1987). These health benefits of dietary fiber for diabetic individuals have been documented by two types of studies: dietary fiber supplementation studies and high-fiber diet studies.

Dietary fiber supplementation studies. Jenkins et al. (1976, 1978) pioneered studies documenting that soluble fibers such as guar and pectin decreased blood glucose response to meals. Nondiabetic as well as diabetic individuals had significantly smaller rises in blood glucose after meals containing soluble fibers than after control meals without fiber. To extend these studies, Jenkins et al. (1977) fed guar-supplemented diets to diabetic subjects for 5 to 7 days. In comparison to control diets, guar-supplemented diets decreased urine glucose by 50%. This group developed guar crispbread for long-term diabetes management (Jenkins et al., 1978) and documented lower insulin requirements and less glycosuria when both insulin-dependent and non-insulin dependent diabetic individuals consumed guar crispbread that provided 14 to 26 g of guar/day. Furthermore, they noted no serious intolerances or adverse effects on mineral status with long-term crispbread use (Jenkins et al., 1980). Numerous other investigators confirmed these observations, as reviewed elsewhere (Anderson and Bryant, 1986e).

High-fiber diet studies. In 1974, we (Kiehlm et al., 1976) developed high-carbohydrate, high-fiber (HCF) diets for the management of diabetes. These weight-maintaining diets provided 70% of energy as carbohydrate, 18% as protein, 12% as fat, and 70 g of fiber daily. Lean diabetic individuals entered the metabolic research ward and ate a traditional diabetes control diet for 7 days, followed by an HCF diet for 14 to 21 days. HCF diets significantly lowered insulin requirements without changes in body weights (Anderson and Ward, 1979). For lean, insulin-dependent diabetic individuals, HCF diets lowered insulin doses by 17% to 77%, with an average reduction of 38%. For lean, insulin-treated diabetic individuals later determined to be non-insulin-dependent, HCF diets lowered insulin doses by an average of 97%; 24 of 25 consecutive diabetic individuals were able to discontinue insulin with HCF diets. Figure 2 illustrates the responses of representative insulin-dependent (Type 1) and non-insulin-dependent (Type 2) diabetic individuals to HCF diets. These diets also decreased fasting serum cholesterol by 27% and triglycerides by 3% (Anderson, 1986a).

We also developed high-fiber maintenance (HFM) diets for practical management of ambulatory diabetic individuals. The HFM diets provided 55% to 60% of energy as carbohydrate, 20% as protein, 20% to 25% as fat, and ≈ 50 g of fiber per day. Most diabetic individuals have demonstrated good adherence to these diets

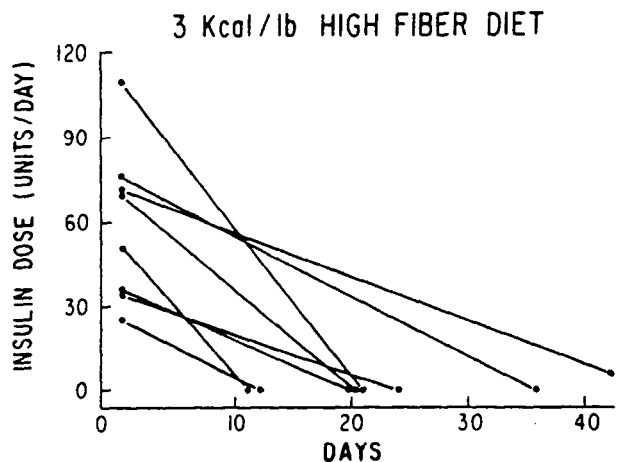


Fig. 2. Responses of representative insulin-dependent and non-insulin-dependent diabetic individuals to HCF diets.

(Anderson and Gustafson, 1989) and have maintained reasonable diabetic control with significantly lower insulin doses for periods of 2 to 15 years; these HFM diets also sustain significantly lower serum cholesterol and triglycerides (Story et al., 1985). As reviewed elsewhere (Anderson and Bryant, 1986f), many other investigators have confirmed the multiple benefits of high-fiber diets for diabetic individuals.

DIETARY FIBER AND SERUM CHOLESTEROL

Hypercholesterolemia is a major contributor to atherosclerosis, leading to coronary, cerebral, and peripheral vascular disease (Anderson et al., unpublished data). Dietary treatment is the first and most important approach to management of hypercholesterolemia, and an estimated 75% of hypercholesterolemic individuals respond to diet (Anderson et al., unpublished data). In the past, dietary management of hypercholesterolemia focused on reducing saturated fat and cholesterol intake (Grundy et al., 1982). Recent studies (Anderson et al., 1984; Thuesen et al., 1986a; Anderson et al., 1989) indicate that increasing dietary fiber intake, especially soluble fibers, can significantly augment the cholesterol-lowering effects of a low-fat diet. These studies are reviewed in detail elsewhere (Anderson et al., unpublished data; Anderson and Tietzen, 1986b) and will be only reviewed briefly here.

Since the early 1960s, many investigators have documented the cholesterol-lowering effects of dietary fiber for humans. Soluble fibers such as pectins, guar (and other gums), and psyllium were studied extensively (Anderson et al., unpublished data). Foods rich in soluble fiber such as fried beans, oats, vegetables and hits also significantly lower serum cholesterol (Anderson et al., unpublished data). Table 2 summarizes studies representative of the extensive work in this area.

Guar gum, a water-soluble polysaccharide that is almost completely fermented in the colon, has been studied extensively in humans. It decreases serum cholesterol 11% and LDL-cholesterol 17% (Anderson et al., unpublished data). Xanthan gum, locust bean gum, karaya gum, and gum arabic, in general, have significant cholesterol-lowering effects in humans, but appear to be slightly less hypocholesterolemic than guar (Anderson et al., unpublished data).

Pectin, which is water-soluble and completely fermented in the colon, also has been studied extensively in humans. It decreases serum cholesterol 11% (Anderson et al., unpublished data). Pectin administration does not significantly affect serum HDL-cholesterol or triglycerides; the effects on serum LDL-cholesterol are not well-documented (Anderson et al., unpublished data).

Psyllium, a hydrophilic mucilloid that is water-soluble and fermentable, has been used for >50 years as a fecal bulking agent. Earlier clinical studies, which did not have optimal control periods or groups (Anderson et al., 1988a), suggested that psyllium might lower serum cholesterol significantly. Using a double-blind, placebo-

Table 2. Serum lipid responses to different fibers. Values are expressed as median percentage change with number of studies in parentheses (Anderson et al., 1990).

Fiber	TC	LDL	HDL	TG ²
Guar	-11 (23)	-17 (10)	0 (14)	-3 (18)
Pectin	-11 (16)	---	-2 (6)	+4 (10)
Psyllium	-14 (10)	---	---	-14 (4)
Oat bran	-16 (8)	-24 (6)	+2 (5)	-8 (5)

²TC = total cholesterol; LDL = low-density lipoprotein cholesterol; HDL = high density lipoprotein cholesterol; TG = triglyceride.

bo-controlled, parallel design, our group demonstrated recently that psyllium at 10.4 g/day decreased serum cholesterol by 14.8% and decreased LDL-cholesterol by 20.2% over an 8-week period (Anderson et al., 1988b). Another carefully controlled study (Bell et al., 1989) recently confirmed these observations.

Soy fiber, which provides ≈37% of its fiber in the soluble form (my unpublished observations), also has significant hypocholesterolemic effects in humans (Anderson et al., unpublished data). On average, the intake of 25 g of soy fiber (18.8 g of dietary fiber and 5.9 g soluble fiber) reduces serum cholesterol from 5% to 9%. Because soy fiber is not as gelatinous as the gums, pectin, and psyllium, it has better formulation and "mouth feel" properties than some of the purified water-soluble fibers.

Oat products gained popularity in recent years, partly because of their hypocholesterolemic effects. Preliminary studies of deGroot et al. (1963) suggested that oatmeal had cholesterol-lowering properties in humans. In 1977, our group began testing oat bran and found it to have substantial hypocholesterolemic effects in humans with high serum cholesterol levels (Kirby et al., 1981). Subsequent studies (Anderson et al., unpublished data) confirmed these observations, indicating that the intake of 100 g of oat bran daily (providing 16 g of dietary fiber and 9 g of soluble fiber) lowered serum cholesterol by 13% to 19% on a metabolic research ward. Figure 3 illustrates the response of hypercholesterolemic males to oat bran intake during a metabolic ward study. Intake of ≈50 g of oat bran in ambulatory studies lowered serum cholesterol by 5% to 10%.

Beans and legumes, both good sources of both soluble fiber and vegetable protein, also significantly lower serum cholesterol effects in humans. Groen et al. (1962) fruit suggested that beans had specific hypocholesterolemic effects. Subsequent studies (Anderson et al., unpublished data) including our metabolic ward studies (Anderson et al., 1984; Anderson et al., unpublished data), further documented that daily intake of 68 to 115 g (dry-weight basis) of beans daily lowered serum cholesterol of hypercholesterolemic males by 13% to 19%. Further studies are required to determine if these hypocholesterolemic effects are related primarily to the soluble fiber content, to the vegetable protein content, to antinutrients such as amylase inhibitors, or to a combination of these factors.

Vegetables and fruits appear to have cholesterol-lowering effects in humans, but further studies are required to assess these effects (Anderson et al., unpublished data). The available studies (Fraser et al., 1981; Masarei et al., 1984b; Robertson et al., 1979; Stasse-Wolthuis et al., 1979a, 1979b, 1980) are difficult to interpret because inclusion of large amounts of vegetable in the diet usually alters the intake of other nutrients, which may affect serum chole-

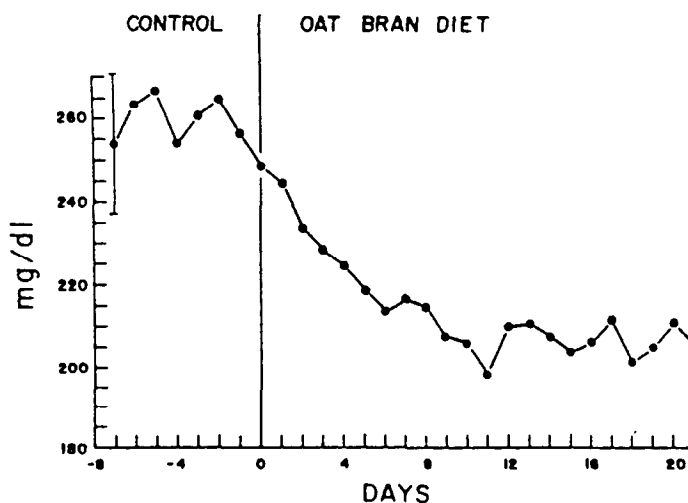


Fig. 3. Response of hypercholesterolemic males to oat bran intake during a metabolic ward study.

terol. Nevertheless, the data available from vegetarians (see above) and from these clinical studies suggest that the intake of large quantities of vegetables and fruits lower serum cholesterol levels.

DIETARY FIBER AND BLOOD PRESSURE

Vegetarians have lower blood pressures, on average, than non-vegetarians matched for age and gender. These observations led to the hypothesis that increased fiber intake may lower blood pressure independent of other dietary variables (Wright et al., 1979). The hypothesis is difficult to prove because increasing dietary fiber intake from high-fiber foods also alters macro- and micronutrient intake (Anderson, 1983b), while feeding subjects purified fibers may fail to show a blood-pressure lowering effect because of fiber changes during the refining process. Several studies will be summarized here to review the potential effects of dietary fiber on blood pressure.

Dobson et al. (1983, 1984a, 1985a) documented the significant blood-pressure-lowering effects of high-fiber diets that also were low in fat and sodium content. While important from a therapeutic standpoint, these studies do not examine the specific effects of dietary fiber on blood pressure.

Lindahl et al. (1984a) noted that a vegan diet lowered blood pressure and medication needs for 29 hypertensive individuals. Both systolic and diastolic blood pressure decreased significantly, and hypertensive symptoms improved over the 1-year period of study. Because this intervention was associated with the change from an omnivore to a vegan diet and with a weight loss of 10 kg, the independent effects of dietary fiber intake cannot be assessed.

The Perth, Australia group has rigorously examined the effects of vegetarian diets and dietary fiber on blood pressure. Their first clinical trial (Rouse et al., 1983) noted that the change from an omnivore diet to a lacto-ovo-vegetarian diet was associated with a significant reduction in blood pressure. Subsequently (Rouse et al., 1986b), they subjected these results to principle components analysis and noted that changes in one group of dietary factors—increased intake of polyunsaturated fat, fiber, vitamin C, vitamin E, calcium, and magnesium and decreased intake of protein and vitamin B12—were significantly and negatively correlated to blood pressure changes. Blood pressure changes were unrelated to changes in body weight or sodium intake. Another study (Margetts et al., 1985) showed that a vegetarian diet lowered blood pressure in mildly affected, untreated omnivores.

Margetts et al. (1987) used a randomized, controlled, cross-over trial to examine the specific effects of dietary fiber intake on blood pressure. Healthy omnivore subjects with normal blood pressure were allocated randomly to one of three groups. One group remained on a control diet while two groups received a low-fiber diet for one of two periods and a high-fiber diet for one of two periods. While blood pressure decreased over time in all three groups, dietary fiber had no consistent effects on systolic or diastolic blood pressure. These findings suggest that dietary fiber may not be the major component of a vegetarian diet contributing to decreased in blood pressure. These observations, consistent with a previous report (Brussaard et al., 1981), indicate that the hypothetical blood-pressure-lowering effects of dietary fiber are not established by careful clinical studies.

DIETARY FIBER AND OBESITY

The intake of high-fiber foods, usually low in fat and energy, protects from obesity, is useful in weight loss, and facilitates weight maintenance. In the modern era, Yudkin (1959), Heaton (1973), and Trowell (1975) suggested a role for dietary fiber in the prevention or management of obesity. Vegetarians, in general, have lower body weights than age- and gender-matched omnivores (Walden et al., 1964c; Sacks et al., 1975c). Furthermore, when individuals are

placed on vegetarian diets for therapeutic purposes, weight loss usually results (Dobson et al., 1984b, 1985b, Lindahl et al., 1984b; Thuesen et al., 1986b).

The mechanisms by which high-fiber diets or fiber supplements promote weight loss and facilitate weight maintenance are still under study. Some of the proposed reasons high-fiber foods promote weight loss are: they take longer to eat, increasing satiety and satisfaction; they slow gastric emptying, contributing to a feeling of fullness; they lower serum insulin, decreasing food intake since insulin stimulates hunger; they decrease the absorption of nutrients, providing less energy than comparable low-fiber foods; they may increase rates of dietary thermogenesis compared to low-fiber foods; their fermentation products, such as gas or short-chain fatty acids, may act to decrease food intake; they may stimulate the release of peptides that could modify feeding behavior, and they may enhance adherence to the diet (Anderson and Gustafson, 1986; Leeds, 1987; Levine et al., 1989; Rodin et al., 1985; Smith, 1987).

Further studies are required to critically examine the effects of high-fiber diets on weight loss. In obese diabetic individuals, high-fiber diets may be especially useful in promoting weight loss as well as improving glycemic control, enhancing insulin sensitivity, and decreasing blood lipids (Anderson, 1986b; Dobson et al., 1984c, 1985c). In nondiabetic individuals, the low-energy density of high-fiber foods may contribute importantly to the weight-loss process (Duncan et al., 1983; Weinsier et al., 1982).

Fiber supplements have a significant, but small, impact on weight loss for individuals participating in a structured diet and weight-loss program. The use of 18 to 24 tablets of a fiber supplement produced significantly more weight loss than observed when placebo tablets were provided (Rossner et al., 1987; Rytting et al., 1984, 1989; Solum et al., 1987).

PRACTICAL IMPLICATIONS

Most individuals in the West ingest suboptimal amounts of dietary fiber. The consensus recommendations of health organizations in western countries is for increased fiber intake; most recommend increases of 50% to 100%, on average, to levels of 20 to 35 g/day. Most Western people are unwilling or unable to modify their eating habits, over the short-term, to include five to six servings of fruits and vegetables plus five to six servings of high-fiber breads, cereals, and legumes daily. Innovative education and marketing efforts may be required to enable consumers to increase, over the long-term, their intake of dietary fiber. In addition to fiber-rich foods, use of concentrated forms of fiber, such as psyllium and soy, may be useful in increasing dietary fiber intake over the short-term.

For individuals with diabetes, hyperlipidemia, obesity and other metabolic conditions, our research group developed high-fiber exchanges (Anderson, 1987a, 1987b). A book for diabetic individuals (Anderson, 1989) outlines specific steps to increase fiber in the diabetes diet. For the general consumers, a cookbook (Anderson, 1986b) and a manual for reducing risk for heart disease (Anderson, 1989) give guidance for increasing fiber intake through use of high-fiber foods. Even with very specific educational material and expert dietetic counseling, many individuals have difficulty achieving the levels of fiber widely recommended.

Because many individuals find it difficult to increase their fiber intake by 50% to 100% through use of high fiber foods, we now recommend use of concentrated forms of fiber in our medical practice. For individuals with diabetes, hyperlipidemia, or obesity, we use psyllium or soy fiber to increment their fiber intake. Since clinical research studies (Anderson, 1988c; Shorey et al., 1985) indicate that it lowers serum cholesterol.

CONCLUSIONS

Dietary fiber provides important health benefits by reducing risk for major common diseases among people in the West. High levels of dietary fiber intake may protect from development of atherosclerotic cardiovascular disease, certain types of cancer, some gastroin-

testinal disorders, hypertension, obesity, and non-insulin-dependent dishes. Furthermore, increasing fiber intake provides therapeutic advantages for management of high blood lipids. certain gastrointestinal disorders, hypertension, obesity, and diabetes.

Dietary fiber, plant cell wall material indigestible in the human small intestine, has water-soluble and -insoluble components. Soluble fibers, including pectins, gums, and mucilages, have hypocholesterolemic effects and decrease blood glucose rises after meals. Insoluble fibers, including cellulose, hemicellulose, and lignin, have important gastrointestinal effects, such as laxation and fecal-bulking properties. Mixtures of soluble and insoluble fibers improve diabetic glucose control and lower serum triglycerides.

The consensus recommendations of health agencies is for increased fiber intake to 50% to 100% above current levels, or to 20 to 35 g/day. The recommended manner to achieve this increase is by intake of five to six servings of vegetables and fruits daily plus five to six servings of high-fiber grain and bean products daily. Concentrated forms of fiber, such as psyllium or soy fiber, may enable some individuals to achieve these targeted levels of daily fiber intake. Innovative education and marketing ventures will be required to enable consumers to achieve fiber intakes of 20 to 35 g/day, but will be cost-effective because of the general health benefits related to high fiber intakes.

Literature Cited

- Abdulla. M., K.-O. Aly, I. Andenon, G. Asp, D. Birkhed, I. Denker, C.-G. Hohanson, M. Jagerstad, K. Kolar, B.M. Nair, P. Nilsson-Ehle, A. Norden, S. Rassner, S. Svensson, B. Akesson, and P.A. Ockerman. 1984. Nutrient intake and health status of lactovegetarians: sampling technique. *Amer. J. Clin. Nutr.* 40:325-338.
- Anderson, J.W. 1981. *Diabetes. A practical new guide to healthy living.* Manin Dunitz London.
- Anderson, J.W. 1983. Plant fiber and blood pressure. *Ann. Int. Med.* 98(2):842-846.
- Anderson, J.W. 1985. Physiological and metabolic effects of dietary fiber. *Fed. Proc., Fed. Amer. Soc Expt. Biol.* 44:2902-2906.
- Anderson, J.W. 1986. Dietary fiber in nutrition management of diabetes. p. 343-360. In: G.V. Vahouny and D. Kritchevsky (eds.) *Dietary fiber (Basic and clinical aspects).* Plenum, New York.
- Anderson, J.W. 1986. *Dr. Anderson's life-saving diet.* The Body Press, Los Angeles. p. 1-128.
- Anderson, J.W. 1987. *HCF exchanges (A sensible plan for healthy eating).* The HCF Diabetes Foundation, Lexington, Ky.
- Anderson, J.W. 1987. *The HCF guide book.* The HCF Diabetes Foundation, Lexington, Ky.
- Anderson, J.W. 1989. *Be heart smart.* HCF Nutrition Research Foundation, Lexington, Ky.
- Anderson, J.W., and C.A. Bryant. 1986. Dietary fiber: diabetes and obesity. *Amer. J. Gastroenterol.* 81:898-906.
- Anderson, J.W., D.A. Deakins, T.L. Floore, B.M. Smith, and S.E. Whitis. 1990. Dietary fiber and coronary heart disease. *CRC Crit. Reviews.* CRC Press, Boca Raton, Fla.
- Anderson, J.W., T.F. Garrity, B.M. Smith, and S.E. Whitis. 1989. A comparison of the effects of high fiber-high carbohydrate and American Hun Association diets on lipid levels. *Absu. in Circ.* 80:II-85. (Suppl.)
- Anderson, J.W., and N-I. Gustafson. 1986. A guide to intensive nutrition management of obesity in diabetes mellitus. *Internal Med. Spec.* 7:100-117.
- Anderson, J.W., and N.J. Gustafson. 1989. Adherence to high-carbohydrate, high-fiber diets. *The Diabetes Educator* 15:429-434.
- Anderson, J.W., N. Gustafson, C.A. Bryant, and J. Tietyen-Clark. 1987. Dietary fiber and diabetes: A comprehensive review and practical application. *J. Amer. Dietetic Assn.* 87:1189-1197.
- Anderson, J.W., N.J. Gustafson, D.B. Spencer, and J. Tietyen. 1990. Serum lipid response of hypercholesterolemic men to single and divided doses of canned beans. *Amer. J. Clin. Nutr.*
- Anderson, J. W., L. Story, B. Sieling, and W.-J.I. Chen. 1984. Hypocholesterolemic effects of high-fiber diets rich in water-soluble plant fibers: Long-term studies with oat-bran and bean-supplemented diets for hypercholesterolemic men. *J. Can. Diet Assn.* 45: 140-149.
- Anderson, J.W., L. Story, B. Sieling, W.-J.I. Chen, M.S. Petro, and J. Story. 1984. Hypocholesterolemic effects of oat-bran or bean intake for hypercholesterolemic men. *Amer. J. Clin. Nutr.* 40:1146-1155.
- Anderson, J.W., and J. Tietyen-Clark. 1986. Dietary fiber: Hyperlipidemia, hypertension, and coronary heart disease. *Amer. J. Gastroenterol.* 81:907-919.
- Anderson, J.W., and K. Ward. 1979. High-carbohydrate, high-fiber diets for insulin-treated men with diabetes mellitus. *Amer. J. Clin. Nutr.* 32:2312-2321.
- Anderson, J.W., N. Zettwoch, T. Feldman, J. Tietyen-Clark, P. Oeltgen, and C.W. Bishop. 1988. Cholesterol-lowering effects of psyllium hydrophilic mucillois for hypercholesterolemic men. *Arch. Int. Med.* 148:292-296.
- Anholm, A.C. 1975. The relationship of a vegetarian diet and blood pressure. *Prev. Med.* 4:35.
- Armstrong, B., A.J.H. Van Merwyk, and H. Coates. 1977. Blood pressure in Seventhday Adventist vegetarians. *Amer. J. Epidemiol.* 105:444-449.
- Amtzenius, A.C., D. Kromhout, J.D. Barth, J.H.C. Reiber, A.V.G. Bruscka, B. Buis, C.M. Van Gent, N. Kemper-Voogd, S. Strikwerda, and E.A. Van Der Velde. 1985. Diet, lipoproteins and the progression of coronary atherosclerosis. *New Engl. J. Med.* 312:805-811.
- Beilin, L.J., B.K. Armstrong, B.M. Margetts, I.L. Rouse, and R. Vandongen. 1987. Vegetarian diet and blood pressure. *Nephron* 47:37-41. (Suppl.)
- Bell, L.P., K. Hectome, H. Reynolds, T.K. Balm, and D.B. Hunninghake. 1989. Cholesterol-lowering effects of psyllium hydrophilic mucillois. *JAMA* 261:3419-3423.
- Brussaard, J.H., J.M.A. van Raaij, M. Stasse-Wolthuis, M.B. Katan, and J.G.A.J. Hautvast. 1981. Blood pressure and diet in normotensive volunteers: Absence of effect of dietary fiber, protein, or fat. *Amer. J. Nutr.* 34:2023-2029.
- Burkitt, D.P. 1969. Related disease-related cause? *Lancet* ii:1229-1231.
- Burkitt, D. 1987. Dietary fibre-histological aspects. *Scand. J. Gastroenterol.* 12:10-13. (Suppl. 129)
- Burr, M.L. 1982. Vegetarianism, dietary fiber, and mortality. *Amer. J. Clin. Nutr.* 36:873-877.
- Burslem, J., G. Schonfeld, M. Howald, S.W. Weidman, and J.P. Miller. 1978. Plasma apoprotein and lipoprotein lipid levels in vegetarians. *Metabolism* 27:711-719.
- Cleave, T.L. 1956. The neglect of natural principles in current medical practice. *J. R. Nav. Med. Ser.* 42:55.
- Cooper, R.S., R.B. Goldberg, M. Trevisan, Y. Tsong, K. Lui, I. Stamler, A. Rubenstein, and A.M. Scanu. 1982. The selective lipid-lowering effect of vegetarianism on low density lipoproteins in a cross-over experiment. *Atherosclerosis* 44:293-305.
- deGroot, A.P., R. Luyken, and N.A. Pikaar. 1963. Cholesterol-lowering effect of rolled oats. *Lancet* ii:303-304.
- Dobson, P.M., P.J. Pacy, P. Bal, A.J. Kubicki, R.F. Fletcher, and K.G. Taylor. 1984. A controlled trial of a high fibre, low fat and low sodium diet for mild hypertension in Type 2 (non-insulindependent) diabetic patients. *Diabetologia* 27:522-526.
- Dobson, P.M., P.J. Pacy, M. Beevers, P. Bal, R.F. Fletcher, and K.G. Taylor. 1983. The effects of a high fibre, low fat and low sodium dietary regimen on diabetic hypertensive patients of different ethnic groups. *Postgrad. Med. J.* 59:641-663.
- Dobson, P.M., P.J. Pacy, and E.V. Cox. 1985. Long-term follow-up of the treatment of essential hypertension with a high-fibre, low-fat and low-sodium dietary regimen. *Hum. Nutr. Clin. Nutr.* 39C:213-220.
- Duncan, K.H., J.A. Bacon, and R.L. Weinsier. 1983. The effects of high and low energy density diets on satiety, energy intake, and eating time of obese and nonobese subjects. *Amer. J. Clin. Nutr.* 37:763-767.
- Fisher, M., P.H. Levine, B. Weiner, L.S. Ockene, B. Johnson, M.H. Johnson, A.M. Natale, C.H. Vaudreuil, and J. Hoogasian. 1986. The effects of vegetarian diets on plasma lipid and platelet levels. *Arch. Int. Med.* 146:1193-1197.
- Fraser, G.E., D.R. Jacobs, J.T. Anderson, N. Foster, M. Palta, and H. Blackburn. 1981. The effect of various vegetable supplements on serum cholesterol. *Amer. J. Clin. Nutr.* 34: 1272-1277.
- Garcia-Palmieri, M.R., P. Sorlie, J. Tillotson, R. Costas, and M. Rodriguez. 1980. Relationship of dietary intake to subsequent coronary heart disease incidence; the Puerto Rico Heart Health Program. *Amer. J. Clin. Nutr.* 33:1818-1827.
- Gordon, T., A. Kagan, M. Garcia-Palmieri, W.B. Kannel, W.J. Zukel, J. Tillotson, P. Sorlie, and M. Hortland. 1981. Diet and its relation to coronary heart disease and death in three populations. *Circulation* 63:500-514.
- Groen, J.J., K.B. Tjong, M. Koster, A.F. Willebrands, G. Verdonck, and M. Pierlott. 1962. The influence of nutrition and ways of life on blood cholesterol and the prevalence of hypertension and coronary heart disease among Trappist and Benedictine monks. *Amer. I. Clin. Nutr.* 10:456-470.

- Grundy. S.U., D. Bilheimer. H. Blackburn. V. Brown, P.O. Kwiterovich. F. Mattson, G. Schonfeld. and W. H. Weidman. 1982. Rationale of the diet-heart statement of the American Heart Association. Report of the Nutrition Committee. *Circulation* 65:839A-854A.
- Haines, A.P., R. Chakrabarti. D. Fisher, T.W. Meade, W.R.S. North, and Y. Stirling. 1980. Hemostatic variables in vegetarians and non-vegetarians. *Thromb. Res.* 19:139-148.
- Hallfrisch, J., J.D. Tobin. D.C. Muller, and R. Andres. 1988. Fiber intake, age and other coronary risk factors in men of the Baltimore Longitudinal Study (1959-1975). *J. Gerontol.: -Med. Sci.* 43:M64-M68.
- Hardinge. M.G., A.C. Chambers, H. Crooks, and F.J. Stare. 1958. Nutritional studies in vegetarians: III. Dietary levels of fiber. *Amer. J. Clin. Nutr.* 6:523-525.
- Hardinge. M.G., and F.J. Stare. 1954. Nutritional studies of vegetarians. Dietary and serum levels of cholesterol. *Amer. J. Clin Nutr.* 2:83.
- Heaton. K.W. 1973. Food fibre as an obstacle to energy intake. *Lancet* ii:1418-1421.
- Hickie, J.B. and J. Ruys. 1976. Serum cholesterol and triglyceride levels in Australian adolescent vegetarians. *Brit. Med J.* 2:87.
- Hjerman, I. 1987. Dietary prevention of coronary heart disease. *Biblhca Nutr. Dieta* 40:23-32
- Jenkins. D.J.A., D.V. Goff. A.R. Leeds. K.G.M.M. Alberti. T.M.S. Wolever, U.A. Gassull, and T.D.R. Hockaday. 1976. Unabsorbable carbohydrates and diabetes: decreased post-prandial hyperglycemia. *Lancet* ii: 172-174.
- Jenkins, D.J.A., T.U.S. Wolever, T.D.R. Hockaday, A.R. Leeds, R. Howarth. S. Bacon, E.C. Apling, and J. Dilawari. 1977. Treatment of diabetes with guar gum: reduction of urinary glucose loss in diabetics. *Lancet* ii:779-780.
- Jenkins, D.J.A., T.M.S. Wolever, A.R. Leeds, M.A. Gassull. P. Haisman, J. Dilawari, D.V. Golf. G.L. Metz, and K.G.M.M. Alberti. 1978. Dietary fibres, fibre analogues, and glucose tolerance: importance of viscosity. *Bnt. Med. J.* 1:1392-1394.
- Jenkins, D.J.A., T.M.S. Wolever. R. Ninham, R. Taylor. C.L Metz, S. Bacon, and T.D.R. Hockaday. 1978. Guar crispbread in the diabetic diet. *Brit. Med. J.* 2:1746-1746.
- Jenkins, D.J.A., T.M.S. Wolever. R.H. Taylor, D. Reynolds, R. Nineham, and T.D.R. Hockaday. 1980. Diabetic glucose control, lipids and trace elements on long-term guar. *Brit. Med. J.* 280:1353- 1354.
- Kahn. H.A., R.L. Phillips. D.A. Snowdon, and W. Choi. 1984. Association between reported diet and all-cause mortality: Twenty-one-year follow-up on 27,530 adult Seventh-Day Adventist. *Amer. J. Epidemiol.* 119:775-787.
- Khaw, K.-T., and E. Barrett-Connor. 1987. Dietary fiber and reduced ischemic heart disease mortality rates in man and women: A 12-year prospective study. *Amer. J. Epidemiol.* 126:1093-1102.
- Kiehm, T.G., J.W. Anderson. and K. Ward. 1976. Beneficial effects of a high carbohydrate, high fiber diet on hyperglycemic diabetic men. *Amer. J. Clin. Nutr.* 29:895-899.
- Kirby, R.W., J.W. Anderson, B. Sicling. E.D. Rees. W.-Jl. Chen. R.E. Miller. and R.M. Kay. 1981. Oat-bran intake selectively lowers serum low-density lipoprotein cholesterol concentrations of hypercholesterolemic men. *Amer. J. Clin. Nutr.* 34:824-829.
- Knuiman. J.T., and C.E. West. 1982. The concentration of cholesterol in serum and in various serum lipoproteins in macrobiotic vegetarian and non-vegetarian men and boys. *Atherosclerosis* 43:71-82.
- Kristein, M.V., C.B. Arnold. and E.L. Wynder. 1977. Health economics and preventive care. *Science* 195:457-462.
- Kritchevsky. D. 1988. Dietary fiber. *Annu. Rev. Nutr.* 8:301-328.
- Kritchevsky. D., S.A. Tepper. and G. Goodman. 1984. Diet- nutrition intake and metabolism in populations at high and low risk for colon cancer: relationship of diet to serum lipids, *Amer. J. Clin. Nutr.* 40:921-926.
- Kromhout. D., E.B. Bosschieter. and C. de Lezenne Coulander. 1982. Dietary fiber and 10-year mortality from coronary heart disease, cancer, and all causes: the Zutphen Study. *Lancet* ii:518-522
- Kushi, L.H., R.A. Lew. F.J. Stare, C.R. Ellson, et al. 1986. Diet and 20 year mortality from coronary heart disease. The Ireland-Boston Diet-Heart Study *New Engl. J. Med.* 312:811-818.
- Leeds, A. 1987. Dietary fibre: Mechanisms of action. *Intl. J. Obesity* 11:3-7. (Suppl.)
- Lemon, F.R., and R.T. Waldon. 1966. Death from respiratory system disease among Seventh-Day Adventist men. *J. Amer. Med. Assn.* 198:117.
- Levine, A.S., J.R. Tallman. M.K. Grace, S.A. Parker. C.J. Billington. and M.D. Leviitt. 1989. Effect of breakfast cereals on short-term food intake. *Amer. J. Clin. Nutr.* 50: 1303-1307.
- Lindahl, O., L. Lindwall, A. Spangberg. A. Stenram. and P.A. Ockerman. 1984. A vegan regimen with reduced medication in the treatment of hypertension. *Brit J, Nutr,* 52:11-21.
- Liu, K., J. Stamler. M. Trevisan, and D. Moss. 1982 Dietary lipids, sugar, fiber, and mortality from coronary heart disease. *Aeterio-clemsis* 2:221.
- McGee, D.L., D.M. Reed, K. Yano. A. Kagan. and J. Tillotson. 1984. Ten-year incidence of coronary heart disease in the Honolulu Heart Program. *Amer. J. Epidemiol.* 119:667-676.
- Malhotra, S.L. 1970. Dietary factors causing hypertension in India. *Amer. J. Clin. Nutr.* 23:1353-1363.
- Margetts, B.M., L.J. Beilin, B.K. Armstrong. and R. Vandongen. 1985. A randomized control trial of a vegetarian diet in the treatment of mild hypertension. *Clin. Exp. Pharmacol. Physiol.* 12:263-266.
- Margetts, B.M., L.J. Beilin, R. Vandongen, and B.K. Armstrong. 1987. A randomized controlled trial of the effect of dietary fibre on blood pressure. *Clin. Sci.* 72:343-350.
- Masarei, J.R.L, I.L. Rouse, W.J. Lynch, K. Robertson. R. Vandongen, and L.J. Beilin. 1984. Effects of lacto-ovo-vegetarian diet on serum concentrations of cholesterol, triglyceride, HDL-C, HDL2-C, HDL3-C, apoprotein-B, and Lp(a). *Amer. J. Clin. Nutr.* 40:468-478.
- Morris, J.N., J.W. Marr, and D.G. Clayton. 1977. Diet and heart: A postscript. *Brit Med. J.* 2:1307.
- National Academy of Sciences. 1989. Diet and health. National Academy of Sciences Press. Washington, D.C.
- Nieman, D.C., B.C. Underwood, KM. Sherman. K. Arabatzis, J.C. Barbosa, and T.D. Schultz. 1989. Dietary status of Seventh-Day Adventist Vegetarian and non-vegetarian elderly women. *J. Amer. Diet. Assn.* 89: 1763-1769.
- Ophir, O., G. Peer, J. Gilad, M. Blum. and A. Aviram. 1983. Low blood pressure in vegetarians: The possible role of potassium. *Amer. J. Clin. Nu.* 37:755-762.
- Phillips. R.L. 1975. Role of life-style and dietary habits in the risk of cancer among Seventh-Day Adventists. *Cancer Res.* 35:3513.
- Phillips, R.L., F.R. Lemon, W.L. Beeson, and J.W. Kuzma. 1978. Coronary heart disease mortality among Seventh-Day Adventists with differing dietary habits: A preliminary report. *Amer. J. Clin. Nutr.* 31:S191-S198.
- Pilch. SM. 1987. Physiologic effects and health consequences of dietary fiber. Life Sciences Research Office, Fed. Amer. Soc. for Expt. Biol., Bethesda. Md. No. 36.
- Robertson, J., W.G. Brydon. K. Tadesse, P. Wenham. A. Walls, and M.A. Eastwood. 1979. The effect of raw carrot on serum lipids and colon function. *Amer. J. Clin. Nutr.* 32:1889-1892.
- Rodin, J., J. Wack, E. Ferrannini- and R.A. DeFronzo. 1985. Effect of insulin and glucose on feeding behavior. *Metabolism* 34:826-831.
- Rossner. S., D. Von Zweigbergk. A. Ohlin, and K. Rytting. 1987. Weight reduction with dietary fibre supplements Results of two double-blind randomized studies. *Acta Med. Scan.* 222:83-88.
- Rouse, I.L. B.K. Armstrong, and L.J. Beilin. 1983. The relationship of blood pressure to diet and lifestyle in two religious populations. *J Hypertension* 1:65-71.
- Rouse, I.L. L-J. Beilin. B.K. Armstrong. and R. Vandongen. 1983. Blood pressure lowering effect of a vegetarian diet: Controlled trial in normotensive subjects. *Lancet* i:5-10.
- Rouse, I.L. L.J. Beilin. D.P. Mahoney, B.M. Margetts. B.K. Armstrong. S.J. Record, R. Vandongen. A. Barden. 1986. Nutrient intake, blood pressure, serum and urinary prostaglandins and serum thromboxane B2 in a controlled trial with a lacto-ovo-vegetarian diet. *J. Hyper-tension* 4:241-250.
- Rytting. K.R., S. Larsen, and L. Haegh. 1984. Treatment of slightly to moderately overweight persons: A double-blind placebo-controlled investigation with diet and fibre tablets (Dumo Vital). *Tidsskrift for Den nonke Laegeforming* 104:989-991.
- Rytting. K-R., G. Tellnes. L. Haegh. E. Boe, and H. Fagerthun. 1989. A dietary fibre supplement and weight maintenance after weight reduction: A randomized double-blind, placebo-controlled long-term trial- *Intl. J. Obesity* 13:165-171.
- Sacks, F.M., W.P. Castelli, A. Dormer. and E.F. Kass. 1975. Plasma lipids and lipoproteins in vegetarians and controls. *New Engl. J. Med.* 292:1148-1151.
- Sacks, F.M., G.H. Handysides. G.E. Marais, B. Rosner. and E.H. Kass. 1986. Effects of a low-fat diet on plasma lipoprotein levels. *Arch. Int. Med.* 146:1573-1577.
- Sacks, F.M., B. Rosner, and E.H. Kass. 1974. Blood pressure in vegetarians. *Amer. J. Epidemiol.* 100:390-398.
- Shorey. R.L. P.J. Day. R.A. Willis, G.S. Lo, and F.H. Steinke. 1985. Effects of soy polysaccharide on plasma lipids. *J. Amer. Diet- Assn.* 85:1461-1465.
- Smith, U. 1987. Dietary fibre, diabetes and obesity. *Intl. J. Obesity* 11:27-31. (Suppl. 1)
- Solum, T.T., K.R. Rytting. E. Solum. and S. Larsen. 1987. The influence of a high-fibre diet on body weight, serum lipids and blood pressure in slightly overweight person: A randomized, double-blind, placebo-controlled investigation with diet and fibre tablets (DumoVital). *Intl. J. Obesity* 11):67-71. (Suppl 1)

- Stasse-Wolthuis, M., H.F.F. Albers, J.G.C. van Jerveren. J.W. de Joog. J.G.A.J. Hautvast, R.J.J. Hermus. M.B. Katan. W.G. Brydon, and M.A. Eastwood. 1980. Influence of dietary fiber from vegetables and fruits, bran or citrus pectin on serum lipids, fecal lipids, and colonic function. *Amer. J. Clin. Nutr.* 33:1745-1756.
- Stasse-Wolthuis, M., J.G.A.J. Hautvast, R.J.J. Hermus. M.B. Katan. J.E. Bausch, J.H. Reitberg-Brussard, J.P. Velema. H.H. Zondervan. M.A. Eastwood. and W.G. Brydon. 1979a. The effect of a natural high-fiber diet on serum lipids, fecal lipids, and colonic function. *Amer. J. Clin. Nutr.* 32:1881-1888.
- Stasse-Wolthuis, M., M.B. Kaun. R.J.J. Hermus, J.G.A.J. Hautvast. 1979b. increase of serum cholesterol in man fed a bran diet. *Athero-sclerosis* 34:87-91.
- Story, L., J.W. Anderson, W.-Jl. Chen, D. Karounos. and B. Sieling. 1985. Adherence to high-carbohydrate, high-fiber diets: Long-term studies of non-obese diabetic men. *J. Amer. Diet Assn.* 85:1105- 1110.
- Thorogood, M., R. Carter, L Benfield. K. McPherson, and J.I. Mann. 1987. Plasma lipids and lipoprotein cholesterol concentrations in people with different diets in Britain. *Brit Med. J. [Clin. Res. Ed.]* 295:351.
- Thuesen, L., LB. Henriksen, and B. Engby. 1986. One-year experience with a low-fat, low-cholesterol diet in patients with coronary heart disease. *Amer. J. Clin. Nutr.* 44:212-219.
- Trowell, H. 1975. Diabetes mellitus and obesity. p. 227-249. In: D.P. Burkitt and H.C. Trowell (eds.). *Refined carbohydrate foods and disease. Some implications of dietary fibre.* Academic, London. Press
- Trowell, H.C. 1975. Dietary-fiber hypothesis of the etiology of diabetes mellitus. *Diabetes* 24:762-765.
- Trowell, H.C. 1981. Hypertension, obesity, diabetes mellitus. and coronary heart disease, p. 3-32. In: H.C. Trowell. and D.P. Burkitt (eds.). *Western diseases. Their emergence and prevention.* Edward Arnold. London.
- Trowell, H.C., and D.P. Burkitt. 1981. *Western diseases. Their emergence and prevention.* Edward Arnold, London.
- U.S. Dept. of Health and Human Services. 1988. *The Surgeon General's Report on Nutrition and Health*, U.S. GPO, Washington, D.C.
- Walden. R.T., LE. Schaefer, F.R. Lemon, A. Sunshine, and E.L Wynder. 1064. Effect of environment on the serum cholesterol-tiglyceride distribution among Seventh-Day Adventist. *Amer. J. Med.* 36:269- 276.
- Walker, A.R.P. 1947. The effects of recent changes of food habits and bowel motility. *S. Afr. Med. J.* 21:590.
- Webster, I.W., and G.K. Rawson. 1979. Health status of Seventh-Day Adventists. *Med. J. Austnl.* 1:417-420.
- Weinsier. R.L. M.H. Johnston. D.M. Doleys. and J.A. Bacon. 1982. Dietary management of obesity: Evaluation of the time-energy displacement diet in terms of its efficacy and nutritional adequacy for long-term weight control. *Brit. J. Nutr.* 47:367-379.
- West. R.O., and O.B. Hayes. 1968. Diet and serum cholesterol levels: A comparison between vegetarians and nonvegetarians in a Seventh-Day Adventist group. *Amer. J. Clin. Nutr.* 21:853-862.
- Wynder, E.L., P.L. Lemon. and I.J. Bross. 1959. Cancer and coronary heart diseases among Seventh-Day Adventists. *Cancer* 12:1016- 1018.
- Wright. A., P.G. Burstyn. MJ. Givney. 1979. Dietary fibre and blood pressure. *Brit. Med. J.* 2:1541-1543.
- Yudkin. J. 1959. The causes and cure of obesity. *Lancet* 82:1135-1138.

Report this Document. Description: Dietary Fibre and Human Health. Copyright: © All Rights Reserved. Available Formats. Download as PDF, TXT or read online from Scribd. Flag for Inappropriate Content. Download Now. Realistic high-fibre and regular low-fibre diets were given for eight week each to NIDDM patients whose diabetes was being controlled satisfactorily by diet alone. The high-fibre diet induced lower fasting blood glucose levels ($p < 0.01$) and decreased the ratio of LDLs to high-density lipoproteins ($p < 0.025$): no difference was found in HbA 1C between the two diet periods. Continuous glucose monitoring also showed a difference in fasting glucose levels that remained after identical low-fibre test meals. The incremental glucose responses did not differ. Dietary fiber is found mainly in fruits, vegetables, whole grains and legumes is probably best known for its ability to prevent or relieve constipation. But foods containing fiber can provide other health benefits as well, such as helping to maintain a healthy weight and lowering your risk of diabetes, heart disease and some types of cancer. Selecting tasty foods that provide fiber isn't difficult. Find out how much dietary fiber you need, the foods that contain it, and how to add them to meals and snacks. What is dietary fiber? Dietary fiber, also known as roughage or bulk, includes the Such food is rich in dietary fibre, with specific physicochemical behaviour and healthy properties. Dietary fibre rich food products are associated with physiological actions in the small and large intestine, having important implications in human health. These properties include water dispersibility and solubility, viscosity effects, bulk, absorption and fermentability, and binding of other compounds. These properties may lead to various physiological actions such as reducing cholesterol and attenuating blood glucose, maintaining gastrointestinal health, and positively affecting calcium bioav However, fiber is a component of plants that is not digested or absorbed by the human GI system. It simply passes through our gut and exits in our stool. Why is it beneficial then if it simply passes through, you may be wondering? Because it adds bulk, creates a softer stool consistency, and aids the transit of stool within our intestines. Prevention of constipation is one of the top reasons people seek a high-fiber diet, and with good reason. Constipation can be uncomfortable causing abdominal pain, bloating, pain with defecation and straining. In addition to maintaining bowel health, however, studies show numerous other potential benefits of dietary fiber: Diverticulitis. Diverticula are tiny out-pouching pockets in the colon and quite common. Although fiber cannot be digested, it is being moved down the digestive tract as nutrients are being digested, and can do some great things that positively impact our health. The problem is that Americans are getting less than half of the daily intake recommendations of 14 grams (g) for every 1,000 calories of food. (1,2) Just as with everything else in life, getting too much fiber can be harmful to your health. The U.S. Dietary Guidelines hasn't established an upper limit on fiber intake, but it's well known that eating too much fiber can cause gas, bloating, and diarrhea. (18) A sudden increase in fiber, inadequate fluid intake, and inactivity, along with a high-fiber diet, may increase the likeliness of these symptoms.