Obesity has become a global epidemic. In the US, two thirds of the population is either overweight (body mass index, 25 < BMI < 30) or obese (BMI > 30). There are only two antiobesity drugs that are FDA approved: Orlistat and Sibutramine. However, side effects have limited their use. Dietary fibers have been reported to reduce fat absorption and to promote health. Many of the countless fiber preparations that are commonly available have been touted as effective for weight loss. A brief review of the most common fibers is presented here. With one exception, FBCx™, none of these fibers have demonstrated their effectiveness in weight loss/maintenance. Both animal and human studies have shown that FBCx™ prevents weight gain and improves blood lipid profiles. As the US population is ingesting about half the recommended daily amount of fiber, augmentation with FBCx™ would appear to be an effective and healthy means of maintaining an appropriate body weight.

Keywords: Dietary fibers; Body weight management; Obesity.

Introduction

Obesity, defined as body mass index (BMI) >30.0 kg/m², has become a worldwide epidemic. It is estimated that 30.5% of the population in the United States is obese and two thirds of the adult population is either obese or overweight (1) (BMI 25.0–29.9 kg/m²). Furthermore, the prevalence of severe obesity (BMI > 40 kg/m², WHO class 3) has more than doubled between 1990 and 2000 (2). The health consequences of being overweight or obese include increased risk for coronary heart disease, hypertension, type 2 diabetes, hyperlipidemia, certain types of cancer, musculoskeletal disorders, sleep apnea, complications in pregnancy, as well as depression and other psychological problems (3). The direct cost of overweight/obesity for health care and indirect costs such as lost productivity was estimated to be a staggering $117 billion in 2000 (4). In the absence of effective treatment, the health care costs will undoubtedly continue to increase.

Dietary fiber is typically defined as a dietary constituent that is not enzymically degraded into absorbable units within the stomach or small intestine. The difference between soluble and insoluble fibers is based upon their relative water solubility. Fermentable vs. nonfermentable relates to whether or not undigested fibers are fermented by the anaerobic flora of the large intestine to yield short-chain fatty acids that may be absorbed and used as an energy source. In addition to fatty acids, gases are also produced by this fermentation.

The concept of increasing dietary fibers for weight management and promotion of good health is not a new one. A recent study (5) indicates that, adjusted for lifestyle factors, each 10 g/d increase in dietary fiber intake lowers the risk of coronary events by 12% and coronary deaths by 19%. Human studies have demonstrated that dietary fiber intake can be used to predict body fat content (6). Obese individuals have significantly higher body fat content and dietary fat intake, and significantly less fiber intake compared with normal weight individuals. It should be noted that there was no difference in energy intake between the obese and normal weight individuals in this study, thus the difference in body weight/fat cannot be attributed to the difference in energy intake (6). Howarth et al. (7) reviewed the literature and concluded that by increasing daily fiber intake by 14 g, significant reduction in energy intake (by 10%) and body weight were apparent. In addition, the weight reduction effect of dietary fiber was more pronounced in obese or overweight than in normal weight humans.

There are countless products available from nutritional food supplement stores, pharmacies, and supermarkets as well as a plethora of websites that contain either specific* fibers or combinations of fibers. Almost all of these products guarantee your satisfaction, but not necessarily your weight loss. All of these products base their (inferred) weight loss claims upon one of two concepts; fiber as a fat absorber or fiber as a bulking agent that increases satiation.

We have attempted to provide a brief description of all of the common fibers that are available as food supplements for weight management.

*Note that the word specific may refer to a class of compounds and does not necessarily reflect on the purity of the fiber.
Chitosan

Chitosan is an amino polysaccharide that is prepared from the powdered shells of crustaceans (e.g., prawns, crabs, and squid pens). It has been suggested that chitosan binds dietary fat thus preventing its absorption and subsequent metabolism.

Most of the research related to this material has been done in animals and has shown positive results, that is, weight reduction. However, human studies have been less promising. Ni Mhurchu et al. (8) conducted a 24-week, double-blind study with 250 overweight or obese volunteers. They found clinically insignificant changes in body weight of about 0.5 kg between the test and placebo populations. Chitosan has been credited for reducing human serum total cholesterol levels by 5.8% to 42.6% and low density lipoprotein (LDL) cholesterol levels by 15.1% to 35.1% (9).

What on the surface at least appears to be a problem is a lack of standardization of chitosan products as well as their dosing. Chitosan is a heterogeneous material; the source and purity information and therefore dosing of a specific chitosan or chitosan mixture is seldom reported in published data. It is conceivable that some chitosans or mixtures of chitosans are more effective at binding fat than are others, although such a comparison study has not been published to our knowledge.

Egger et al. (10) have pointed out that loss of essential nutrients and steatorrhea are potential problems with chitosan. Surely this concern can be raised with any fat “binder” product. However, we have been unable to find any reports that might substantiate such concerns. One cautionary note that is often repeated in the literature is that chitosan products may be dangerous to those individuals who have allergic reactions to crustaceans. As the major shrimp allergen is the muscle protein tropomyosin (11), one might imagine that chitosan preparations of low quality could be contaminated with proteinaceous material. However, we have been unable to find a single report to this effect. A review of the FDA food recalls for 1999 because of undeclared food allergens does not list a single crustacean event (12).

Pectin

Howarth et al. (13) conducted a short 3-week study evaluating the use of both fermentable and nonfermentable fibers for increasing satiety and decreasing food consumption. In this single-blind study volunteers were directed to consume up to 10 g of fiber with 355 mL of a noncaloric beverage thirty minutes before each meal three times each day (i.e., 30 g/d). The fermentable fiber used in this study was a 2:1 mixture of pectin from citrus peel and β-glucan from oat extract. The authors concluded after 3 weeks ad-lib feeding, that neither fermentable fiber nor nonfermentable fiber had any beneficial effects in promoting weight loss in humans. In their review of the literature Egger et al. (10) were unable to find evidence that pectin will cause weight reduction by increasing satiety. However, it has been shown that β-glucan has been demonstrated to lower both total and LDL cholesterol (14).

Methylcellulose

The nonfermentable fiber used by Howarth et al. (13) in the study mentioned above was Methocel, the Dow Chemical name for hydroxypropyl methylcellulose. The trial design was also identical to that of the pectin/β-glucan study. Similarly, this short-term, high-dose study elicited no obvious weight loss in the volunteers.

Guar gum

Pittler and Ernst (15) have performed a meta-analysis on 11 published trials that looked at guar gum as a bulking agent for appetite suppression. The results of their statistical analysis suggest that guar gum is ineffective in reducing body weight. In 1992 the FDA banned guar gum for use in diet products because it “...was found to be neither safe nor effective” (16). In support of their decision the FDA cited numerous reports that guar gum posed a health hazard (16) because of the formation of esophageal, stomach, and intestinal blockages. Guar gum is acceptable for use in low doses and for purposes other than weight loss.

Psyllium

Psyllium, derived from the husks of Plantago ovata, has been credited with lowering serum glucose, triglyceride, total and LDL cholesterol and raising HDL cholesterol in a study that involved three 5-g doses per day (17). However, neither this study nor the review of Pittler and Ernst (15) found any significant effect on weight loss.

Alpha-dextrin

Alpha-dextrin is an old, well-studied material that has found a new use. In a study conducted by Artiss and Jen it was demonstrated that by feeding this material to rats at a rate of 10% of the amount of fat in the animals’ diets that the rats on a high-fat diet (69% of caloric intake) gained weight significantly slower than did the animals on the same diet without the α-dextrin (18). At the time of this writing, placebo-controlled, double-blind clinical trials in an obese (BMI > 30) diabetic population are nearing completion. Preliminary data gleaned from this study demonstrates that α-dextrin significantly reversed the weight gain that the test group had experienced prior to the study and that the study placebo group continued to experience throughout the study. In addition, the test group effectively lowered both their total and LDL cholesterol while increasing their HDL cholesterol. Alpha-dextrin is easily
tolerated by humans and is effective at relatively low levels (6 g/d).

**Discussion**

Despite the beneficial effects of dietary fiber on body weight, the average adult daily intake of fiber in the United States is about one half the recommended levels (19). Popular diet plans like Atkins and South Beach exacerbate this situation further (19). Thus it might be argued that, generally speaking, any mechanism by which the consumption of dietary fiber is increased is good for the health of the public.

We have not attempted to address the health benefits of “all” dietary fibers, rather the selected few that are sold over the counter, individually or in formulations, for weight loss. With the exception of large doses of guar gum, none of the fibers mentioned above appear to be unsafe for human consumption. However, this is a “buyer beware” market with relatively few regulations. As the sources, contaminants, and purities of “all natural” and “herbal” preparations are not regulated the consumer is well advised to purchase such products from reputable suppliers. The FDA regulations as well as advice to the consumer regarding over-the-counter products may be found on their website (20).

It may be of some benefit to briefly describe the US regulations that pertain to over-the-counter products. Prior to introducing a new “dietary supplement” for interstate commerce a manufacturer is required to file a pre-market notification with the FDA (21). If allowed by the FDA the manufacturer is basically told that the agency agrees with the manufacturer’s interpretation of the safety data that was supplied by the manufacturer. Note that by allowing the product to be sold the FDA is not declaring that the product is safe, rather that they agree with the manufacturer’s interpretation of the safety data that was submitted by the manufacturer. One might assume that it would not be in the manufacturer’s best interest to submit contradictory evidence. Once the manufacturer has received this allowance they are free to market their product, as long as there are no claims on the label.

Should the manufacturer wish to make a claim it must be a “structure function” and not a “disease” claim unless they have prior approval to do so. If a structure function claim is made on the label, the manufacturer has 30 days, after their first sale, to notify the FDA of the claim. We have included the following quote from the compliance guide to give the reader an appreciation for what it takes to say, “You can’t claim that your product does something if it in fact does not do it!”:

Dietary supplement labels or labeling may, subject to the requirements in paragraphs (a) through (e) of this section, bear statements that describe the role of a nutrient or dietary ingredient intended to affect the structure or function in humans or that characterize the documented mechanism by which a nutrient or dietary ingredient acts to maintain such structure or function, provided that such statements are not disease claims under paragraph (g) of this section. If the label or labeling of a product marketed as a dietary supplement bears a disease claim as defined in paragraph (g) of this section, the product will be subject to regulation as a drug unless the claim is an authorized health claim for which the product qualifies.

For more details and links to the Federal Registry, please check their website (22).

Once the product is marketed, enforcement and product advertising becomes the purview of the Federal Trade Commission (FTC). As you can see from their industry guide (23), they appear to be most concerned about truthful advertising. In his address to the Committee on Energy and Commerce Subcommittee on Oversight and Investigations (24), J. Howard Beales, III Director, Bureau of Consumer Protection stated that:

Since 1997, the FTC has brought seven enforcement actions challenging efficacy and safety/no side effects claims for supplements containing ephedra.

These cases have challenged claims for ephedra products marketed for weight loss, body-building, and energy supplements, and as alternatives to street drugs such as Ecstasy. In these cases, we have challenged allegedly deceptive efficacy and safety claims as false or unsubstantiated. Our orders have required a strong disclosure warning about safety risks in future advertising and labeling.

It is of interest that in these early actions against ephedra-containing products that the FTC does not appear to be claiming that ephedra is not safe, only that it was not labeled appropriately. It may also be of interest that, unlike pharmaceuticals, manufacturers of dietary supplements are not required to document adverse events. Thus for the FTC to challenge claims based upon safety issues they will need to conduct their own investigation including the collection of their own data. Considering that the dietary supplement market was estimated to be $17.7 billion in 2001 (25), enforcement of the regulations is no small task.

There are a plethora of alternatives to fiber for weight loss. As mentioned above, ephedra, although popular, has been taken from the market for safety reasons. There are seemingly countless ingredients and combinations of ingredients all purporting weight loss; unfortunately, it is not obvious that any of them elicit beneficial effects. The reader is directed towards the review articles of Egger (10) and Pittler and Ernst (15) for a comprehensive description of these products. At
present there are only two pharmaceutical treatments for obesity that are FDA approved for long-term use—Orlistat and Sibutramine. Orlistat inhibits pancreatic lipase activity in the small intestine. Used in conjunction with a hypo-caloric diet, this pharmaceutical agent has been demonstrated to induce modest weight loss and better weight maintenance than diet alone (26). However, without significant dietary changes and behavior modification the adverse effects of gastrointestinal discomfort, flatulence, and diarrhea, make compliance an issue (26). Furthermore, long-term efficacy and safety has not been established (27). Sibutramine is a serotonin and norepinephrine reuptake inhibitor that suppresses appetite and therefore causes weight loss (28). However, the FDA has approved it for the treatment of obesity no more than two consecutive years. As Sibutramine inhibits the reuptake of norepinephrine, it may increase blood pressure and is therefore contraindicated for use in some obese patients (29–30). In addition Sibutramine may cause increased heart rate, insomnia, constipation, headache, abdominal pain, etc. In combination with a hypo-caloric diet and lifestyle changes, Sibutramine has been demonstrated to have beneficial effects in normotensive obese patients (30). There are numerous new pharmaceuticals in various stages of clinical trial that may offer benefits at some time in the future. It is of note, however, that many of these new drugs target one or more neural transmitters or receptors and may therefore elicit side effects similar to Sibutramine.

Conclusion

Although some of the commonly available fibers have demonstrated positive effects on blood lipid levels, none have been demonstrated to elicit significant effects on weight loss or management in humans except for the one notable exception, α-dextrin, which not only appears to have positive effects on blood lipid levels but also on body weight reduction and management. Animal studies into the effects of α-dextrin have also indicated positive effects on blood insulin and leptin levels suggesting that it may elicit beneficial effects on metabolic syndrome. The need for a treatment for obesity and diabetes should be obvious to all of us; 15 years ago would any of us have seriously considered type II diabetes a possible diagnosis in a 10-year-old child?

References


From the Department of Pathology and Center for Molecular Medicine and Genetics, Wayne State University, Detroit, Michigan; ‡ArtJen Complexus Inc., Windsor, ON, Canada; and the Department of Nutrition and Food Science, Wayne State University, Detroit, Michigan.
Correspondence to: Joseph D. Artiss, Associate Professor, School of Medicine, Pathology, 456 Lande, Department of Pathology, Detroit, MI 48201 (e-mail: jartiss@wayne.edu).