The Health Benefits of Psyllium

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INTRODUCTION

Today the interest in nutrition and nutrition research relates primarily to optimizing health and to the prevention of chronic disease, rather than focusing on adequate food intake and nutrient deficiencies. In the quest for optimal health, Canadians and peoples of other Western nations have an increased awareness of the role of lifestyle in chronic disease. Part of a healthy lifestyle is of course a healthy diet and many are becoming increasingly interested in the role of "functional foods," foods and food ingredients with specific health benefits.

One long known functional food component is psyllium. Psyllium has been used for centuries as an herb and remedy for the treatment of skin irritations, diarrhea and hemorrhoids. More recently it has been studied by Western medicine for over a quarter century. Its properties suggest that psyllium may have beneficial effects on a broad range of metabolic functions. There is strong evidence that psyllium has laxative properties and promotes colonic function. There is some indication that psyllium may decrease the glycemic response of foods and, thereby, may help to regulate blood glucose concentrations, possibly aiding in the control of diabetes and decreasing hunger to aid with weight loss and preventing overweight and obesity. There is also strong evidence to indicate that psyllium decreases serum cholesterol levels and therefore may be helpful in decreasing risk of coronary heart disease. However, while the laxative and cholesterol-lowering properties of psyllium are well established, its role in preventing other colonic diseases and controlling or preventing diabetes and weight gain is less clear. The goal of this brief review is to provide an update on the current status of the research on psyllium and health.

PSYLLIUM

Psyllium fibre, also known as Ispaghula and Isapgol, is derived from the husk and seeds from *Plantago psyllium* and more commonly *Plantago ovata*. Psyllium is an herb native to parts of Asia, the Mediterranean regions of Europe and North Africa, and is now widely cultivated in India and the American southwest.

GASTROINTESTINAL FUNCTION AND COLONIC HEALTH

Psyllium is classified as a mucilaginous fibre due to its gel-forming properties in water. It has a long history of use as a laxative as it absorbs water and expands as it travels through the digestive tract. For this reason it is referred to as a bulk-forming laxative. Through numerous studies it is well-recognized that psyllium decreases gastrointestinal transit time and increases stool weight and moisture content. Larger and softer stools are simply easier to pass, thereby preventing or alleviating constipation and hemorrhoids caused by straining during defecation. It is important to note that other considerations for the prevention of constipation include, eating a well-balanced diet and regular meals, drinking plenty of fluids, taking exercise regularly and establishing regular toilet habits.

The psyllium husk contains largely insoluble fibre, (hemicellulose), which helps to retain water within the bowel and effectively increases stool moisture content and weight. The epidermis of the seed also contains insoluble fibre (cellulose, hemicellulose and lignan) and in addition contains a high proportion of soluble fibre which is partially fermented in the large bowel to the short chain fatty acids, acetate, propionate and butyrate. Butyrate is the preferred metabolic substrate for colonocytes and appears to be helpful for maintaining the health of the colonic epithelium and may be useful in the treatment of ulcerative colitis.

A fairly recent study assessed the effect of psyllium, mesalamine (5-aminosalicylic acid: commonly used for reducing intestinal inflammation associated with ulcerative colitis) and mesalamine plus psyllium in a parallel-design study with 102 subjects treated for 12 months. Psyllium was found to significantly increase fecal butyrate concentrations and was found to be as effective as the standard therapy in preventing remission of the disease. In another study in rats, psyllium was found to increase butyrate generation which was found in *in vitro* studies to inhibit the production of pro-inflammatory mediators. While these few studies are promising, the role of psyllium in the treatment and prevention of ulcerative colitis requires much further study before definitive answers are arrived at.

Irritable bowel syndrome is characterized by recurrent episodes of abdominal pain and discomfort and disturbed bowel habits. While the etiology of this disease remains unknown, standard medical advice is to increase fibre intake through diet and fibre-bulking agents. A number of studies have assessed the effect of soluble and insoluble fibre in the treatment of irritable bowel syndrome. Of the eight studies conducted thus far with psyllium, six have found an improvement in recurrent irritable bowel symptoms with psyllium supplementation after intervention periods of 3 to 12 weeks. While these results are promising, many more studies are required to establish the efficacy of psyllium in the treatment of this disease.

REDUCED POSTPRANDIAL GLUCOSE AND DIABETES CONTROL

It is believed that fibre-depleted foods lead to higher glucose levels and stimulate excessive insulin secretion. Hyperinsulinemia, in turn, may result in down-regulation of insulin receptors, lower levels of relevant signaling molecules and, thus, an increase in fasting blood glucose concentrations. Once established, insulin resistance may result in an even greater sensitivity to the deleterious effect of low fibre, high glycemic index foods, thus maintaining a vicious cycle. Viscous fibres, such as psyllium, ß-glucan, guar and pectin, may act to break this cycle by reducing the rate of absorption and lowering the postprandial glycemic and insulinemic responses. To achieve these effects viscous fibres function by converting the small intestine into a storage organ for the slow release of glucose to the portal circulation. In this way fibre may decrease the risk of Western chronic diseases (diabetes, obesity and heart disease) by ameliorating the rapid rise and falls in blood glucose and insulin which result from consuming a highly refined high glycemic index diet.

Psyllium incorporated into foods, such as pasta, and isolated psyllium when added to a test meal (glucose) has been shown to reduce postprandial glucose and insulin concentrations. Psyllium and other viscous fibres may prove to be effective treatments for blunting postprandial glucose concentrations and in preventing and controlling diabetes as has been demonstrated with acarbose, an alpha-glucosidase inhibitor that slows the absorption of glucose from the gut. Two recent studies have assessed the effect of psyllium in diabetes control. In these studies psyllium fed at levels of 10 g/d and 14 g/d significantly improved markers of glycemic control and reduced serum total cholesterol levels. While the acute effects of viscous fibres, including psyllium, in blunting postprandial glucose is well established, many more clinical trials will be required before its effectiveness in the prevention and control of diabetes can be established.

APPETITE AND WEIGHT CONTROL

Psyllium may be beneficial in decreasing appetite and in weight control through its ability to decrease the rate of glucose absorption and its bulk-forming properties in the gastrointestinal tract, which may enhance the feeling of satiety. In a study designed to assess the effect of psyllium on appetite variables, nutrient and energy intakes, 17 women undertook three, 3-day study periods in random order consisting of: psyllium (20 g granules with 200 mL water), placebo (20 g granules with 200 mL water), or water (200 mL) 3 hrs pre-meal and the same dose immediately pre-meal. A set meal was given at lunch time after the supplement to subjects who had fasted overnight. Visual analogue scales were completed premeal, postmeal and at hourly intervals for 3 hrs after the meal. All food consumed on the meal day, and the following day was weighed. Subjects noted a significant increase in fullness at 1 hr postmeal with psyllium compared to the placebo and water treatments. Total fat intake was also significantly lower in g/d and as a percentage of energy on the day of the meal with the psyllium treatment compared to water. While these short-term effects of psyllium in controlling appetite are of interest, there are few longer term studies of its effects on weight loss. One study has found that psyllium decreased serum lipids, glycemia and body weight in obese and diabetic patients, while a more recent double blind study found no effect on weight loss but improvements in glucose homeostasis and the lipid and lipoprotein profile of obese children and adolescents. In none of these studies was weight loss the primary outcome measure and such studies are required before the question regarding the usefulness of psyllium in weight loss is answered.

CORONARY HEART DISEASE: EFFECTS OF PSYLLIUM ON SERUM LIPIDS

In Canada and other Western nations there has been a steady decline in the rate of death from cardiovascular disease over the past 25 years. However, it still remains the leading cause of death in Canada, accounting for 37% of total deaths. There is a strong link between blood cholesterol concentrations and risk of death from coronary heart disease. Individuals with blood cholesterol levels less than 5.2mmol/L have a low risk of death from heart disease, and as cholesterol levels rise, the disease risk increases dramatically. Medium risk is considered between 5.2 and 6.2 mmol/L and high risk is greater than 6.2 mmol/L. Most adults in North America have elevated levels of cholesterol and are in the medium and high-risk groups.

Viscous fibres have been recognized since the 1960s as having cholesterol-lowering properties. They have also been shown to reduce postprandial glycemia and insulinemia. They appear to achieve this through increasing the viscosity of the luminal contents within the intestinal tract, thereby slowing the rate of nutrient absorption. In terms of serum cholesterol reduction, their primary mechanism of action is likely to relate to their ability to increase bile acid loss. Bile acids are produced in the liver from cholesterol. Thus an increase in bile acid excretion requires more bile acid production from cholesterol, which translates into a reduction in the body's cholesterol pool. Other possible mechanisms include alterations in the production of short chain fatty acid production through colonic fermentation of fibre, dampening postprandial insulin surges and altering postprandial lipoprotein synthesis, possibly stimulating reverse cholesterol transport through altering the rate of nutrient absorption, all of which may contribute to reducing serum cholesterol levels.

The effects of psyllium were examined on cholesterol reduction at two levels of monounsaturated fat (MUFA), using wheat bran as the control and matching for total fibre intake. In both the lower fat (~6% of energy as MUFA, 20% total fat) and higher fat (12% of energy as MUFA, 29% total fat) diets, the addition of 12 g psyllium per day from *Kellogg's® All-Bran Buds®* cereal with psyllium for one month significantly reduced serum LDL-cholesterol levels

Table 1: Meta-Analyses of Psyllium and LDL Reduction

	Number of Studies	Number of Subjects Taking Psyllium	Average Dose	Mean LDL Starting Value (mmol/L)	LDL Cholesteral % Reduction
Olson et al. 1997	12	209	9.4	4.33	7.4%
Brown et al. 1999	17	479	9.1	4.37	6.0%
Anderson et al. 1999	8	384	10.2	4.19	7.2%

by 12% and 15%, respectively. Psyllium intake was also found to be negatively correlated with the change in the LDL:HDL cholesterol ratio (r=-0.34, P=0.019). The synthesis rate of one of the primary bile acids, chenodeoxycholate, was increased by 30% (P = 0.038) with the psyllium diet.

Quite recently three meta-analyses have been performed looking at the cholesterol-lowering effects of psyllium (Table 1). In the first study, the assessment was restricted to the effect of psyllium-enriched breakfast cereals in hypercholesterolemic subjects. The second had a broader scope and was designed to assess the cholesterol-lowering effects of psyllium as well as the other major dietary fibres in both normocholesterolemic and hypercholesterolemic subjects. The third study was designed to assess the effects of psyllium when used adjunctive to a low-fat diet in men and women with hypercholesterolemia. There was some overlap in the clinical studies used in these three meta-analyses. Mean psyllium intakes on these studies were 9.4 g, 9.1 g and 10.2 g per day, and this produced remarkably similar reductions in LDL-cholesterol of 7.4%, 6.0% and 7.2%, respectively (Table 1). These studies provide strong support for the cholesterol-lowering properties of psyllium and for its effective use for decreasing risk of coronary heart disease.

FDA HEALTH CLAIM FOR PSYLLIUM AND CORONARY HEART DISEASE

The strong evidence that psyllium and other viscous fibres including ß-glucan may prevent CHD is reflected in the recent U.S. Food and Drug Administration (FDA) health claims for viscous fibres. As concluded by the FDA, scientific studies indicate that 10.2 g of psyllium daily, providing approximately 7 g of viscous fibre, in the diet is needed to show a significant LDL-cholesterol lowering effect. In order to qualify for a health claim, a food must contain at least 2.5 g of psyllium (1.7 g viscous fibre) per serving, the amount that is one-fourth of the effective level of 10.2 g/d. An example of a health claim for the relationship between psyllium in the diet and the reduced risk of heart disease is: "The soluble fiber from psyllium seed husk in this product, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease."

We have assessed the effects of consuming 8 g/d of a combination of the viscous fibres psyllium and ß-glucan, an amount that meets the FDA requirements for a health claim for cardiovascular disease risk reduction. The high fibre diet included three servings of psyllium containing foods and one serving of ß-glucan containing foods per day and resulted in reductions in total cholesterol of 2.9% (P=0.001), LDL:HDL cholesterol of 2.4% (P=0.015) and applying the Framingham cardiovascular disease risk equation a reduction in of 4.2% (P=0.003). This data supports the FDA's approval of a health claim for the viscous fibres psyllium and ß-glucan at an intake of four servings/d.

CONCERNS SURROUNDING PSYLLIUM CONSUMPTION

There are few adverse effects associated with psyllium consumption. In some individuals the high soluble fibre, and resulting increased fermentation has resulted in increased flatulence, bloating and abdominal discomfort. In one of the longest term studies with psyllium, 93 subjects took 10.5 g of psyllium daily. Psyllium was found to be well tolerated and the majority of adverse events recorded were minor, of short duration and either unrelated or possibly related to the study treatment. While statistically significant changes in some measurements of minerals and vitamin levels, and in some hematological and biochemical parameters were noted, none of these were of clinical significance, with the possible exception of changes in vitamin B12 levels.

There have been cases of viscous fibres taken in capsule form swelling in the throat and causing choking. There have also been cases of allergic and anaphylactic reactions to psyllium and while these are extremely rare caution is recommended.

Based on the evidence at hand, psyllium may be recommended at daily intakes of approximately 10 g. This dose appears to be most acceptable when divided over the day. It is also recommended that individuals increase doses in a graded manner to avoid gastrointestinal upset and that individuals maintain proper hydration to avoid constipation. Psyllium is most effective when taken in food form or if taken as a supplement mixed with an appropriate amount of water or other liquids.

HOW CAN PSYLLIUM BE INCLUDED IN THE DIET?

Psyllium can be included as part of a healthy diet following *Canada's Food Guide to Healthy Eating*. With regard to LDL-cholesterol lowering, it appears that benefits accrue at relatively low levels of 10.2 g psyllium per day. If a reduction in CHD risk is sought, we would recommend a "portfolio" approach, where psyllium and other viscous fibre containing foods are used along with other cholesterol-lowering foods and food components. In this way, we believe benefits can be realized by a manageable comprehensive dietary change rather than an extreme change concentrating on one dietary component alone. Use should be made of psyllium and other viscous soluble fibres, soy protein, plant sterols and nuts in combination (Table 2). All of these foods and food components have now received approval by the FDA for health claims for cholesterol reduction. By incorporating these foods into a diet already low in saturated fat and dietary cholesterol, we have observed serum cholesterol reductions of up to 35% after only four weeks. In our third study, the portfolio diet was found to be more effective than the standard low-saturated fat diet (control) and as effective as the starting dose of a statin medication in LDL-cholesterol and the LDL:HDL-cholestserol ratio (Figure 1). The portfolio diet was also found to lower concentrations of the inflammatory biomarker C-reactive protein (Figure 1), higher levels of which have been related to increased risk of cardiovascular events.

The aim of the portfolio diet was to provide 10 g/d viscous fibres per 1,000 kcal of diet from psyllium, oats and barley; 1 g plant sterols per 1,000/kcal of diet in a plant sterol enriched margarine; 21 g soy protein per 1,000 kcal of diet as soy milk and soy meat analogues; and 14 g whole almonds per 1,000 kcal of diet. Such a dietary approach is in accordance with the guidelines of the National Cholesterol Education Program Panel III, the American Heart Association and the Canadian Working Group on Hypercholesterolemia and Other Dyslipidemias. Further studies on the portfolio diet are ongoing and planned to its effectiveness in less tightly controlled *ad libitum* applications.

Table 2. A Portfolio of Dietary Factors for Cholesterol Reduction

Dietary Component	Dietary Change	Approximate LDL Reduction
Saturated Fat*	< 7% of calories	10%
Dietary Cholesterol	< 5.2 mmol/L	5%
Psyllium and other Viscous Fibers	5 – 10 g/d	5%
Soy Protein	25 g/d	5%
Plant Sterols	1 – 3 g/d	5%
Almonds and other Nuts	30 – 60 g/d	5%
Total	Full Portfolio	35%

* Reduce trans fatty acid as close to zero as possible

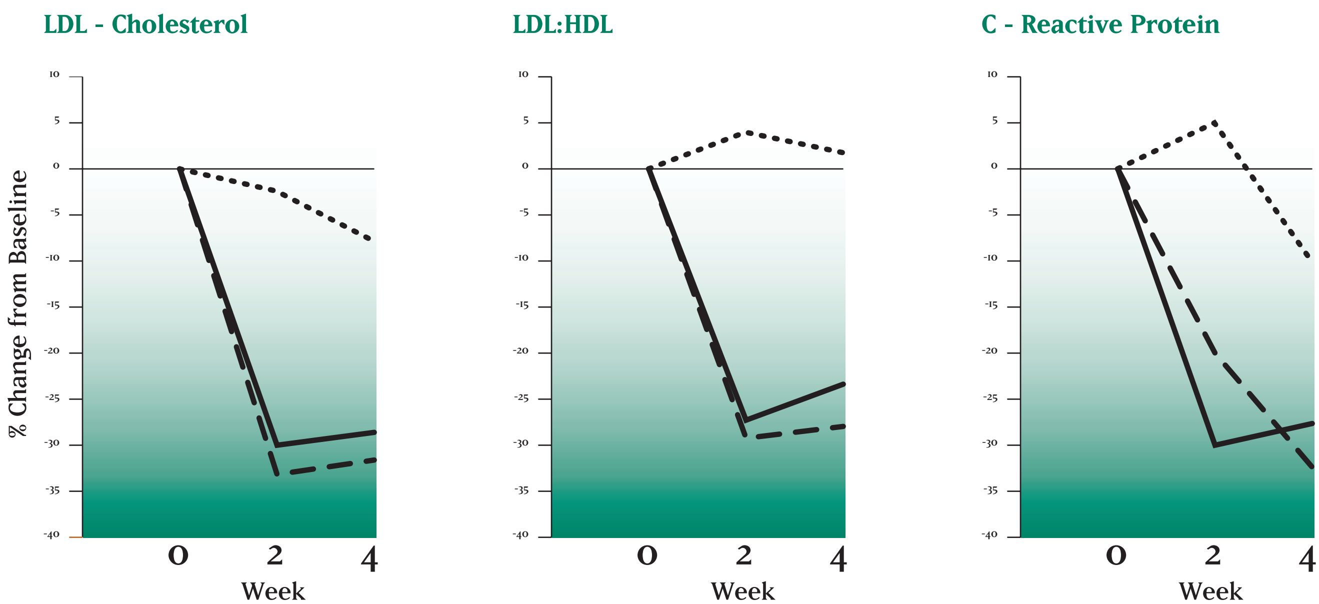

Figure 1. Effect of a Portfolio Diet of cholesterol-lowering foods (solid line) compared to Statin treatment (dashed line) and a standard NCEP cholesterol lowering diet (dotted line) on LDL-cholesterol, the LDL:HDL-cholesterol ratio and the inflammatory biomarker, C-reactive protein.

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