Oat Bran as a Cholesterol-Reducing Dietary Adjunct in a Young, Healthy Population

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In a study to examine the effects of dietary oat bran on serum lipids, subjects who ate two oat bran muffins a day for 28 days showed a 5.3% reduction in serum total cholesterol and an 8.7% reduction in low-density-lipoprotein-cholesterol levels, while no changes were noted in subjects consuming wheat or mixed wheat and oat bran muffins. Similarly, those who ingested oat bran muffins showed an 8.3% reduction in serum triglyceride values as contrasted with an overall increase of 6.4% in the other groups combined. These findings suggest that oat bran taken daily can significantly lower serum cholesterol and triglyceride levels in a young, healthy population.

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Cardiovascular disease is the leading cause of death in the United States.[1] Elevated levels of serum total cholesterol and low-density-lipoprotein cholesterol (LDL) and low levels of high-density-lipoprotein cholesterol (HDL) have been recognized as risk factors in the development of atherosclerosis and coronary artery disease.[2] It has been shown that reducing the levels of blood cholesterol and LDL cholesterol decreases the risks for coronary artery disease.[3,4] Several dietary factors have been associated with serum cholesterol and LDL-cholesterol levels, including the amount and quality of fat, dietary cholesterol, fiber, and carbohydrate intake.[5] With increasing evidence that atherogenesis begins early in life,[6] the rationale for cholesterol-reducing dietary modifications published years ago[7] becomes particularly relevant to younger segments of our population. This study adds to the work of others showing cholesterol-reducing properties of certain dietary fibers and specifically evaluates oat bran as a hypocholesterolemic agent in healthy young adults.

Dietary fibers, which have been defined as all "nondigestible cell wall components," can be subdivided into water-soluble and water-insoluble components.[8] Water-soluble fibers such as those abundant in oat bran, beans,[9] guar gum,[10] and fruit pectin[11] have been reported to lower serum cholesterol levels. The cholesterol-reducing effect of water-soluble fiber has been further shown to selectively lower LDL-cholesterol levels, sparing or actually raising the cardioprotective HDL-cholesterol fraction.[9,12] In contrast, a number of studies indicate that wheat bran and other sources rich in water-insoluble fibers do not lower serum cholesterol levels.[11,13] The serum triglyceride effects of high-fiber diets have varied.[8]

Compared with wheat bran's 46% dietary fiber content, oat bran is 30% dietary fiber by weight. Only 8% of the wheat bran fiber is water-soluble, however, while more than 50% of oat-bran fiber is water-soluble. Thus, a gram-equivalent dose of oat bran provides about four times as much water-soluble fiber as wheat bran, and a dietary fiber equivalent dose provides more than six times as much water-soluble fiber.[14]

Using dietary fiber equivalent doses of either oat, wheat, or wheat and oat bran combined, we designed a prospective, randomized, double-blind, controlled study to determine if modest daily doses of oat bran effectively reduce serum cholesterol levels.

Subjects and Methods

Study subjects were volunteers from the first- and second-year medical student classes at the University of California, Irvine, who had completed a three-day record of their prestudy dietary habits. Informed consent was obtained for each subject as specified by the University Human Subjects Review Committee. Subjects were randomly assigned to one of three groups to receive muffins containing one of the following dietary fiber sources: wheat bran and whole wheat flour, oat bran mixed with wheat bran and whole wheat flour, or oat bran alone. These three groups are referred to as "wheat," "wheat/oat," and "oat bran" groups, respectively. Dietary fiber gram-equivalent formulations were achieved using whole wheat flour, wheat bran, and oat bran in a 1:2:3 weight ratio. Muffins were prepared by a licensed professional bakery by adding the different fiber sources to the following basic recipe (relative composition shown by percent of total weight): skim milk (31%), refined wheat flour (8%), brown sugar (16%), vegetable shortening (8%), egg whites (6%), honey (2%), blackstrap molasses (3%), salt and baking soda (< 1%), and the respective fiber sources (24%).

Three-day food records submitted by each subject and each muffin recipe (Table 1) used were analyzed for specific nutrients using ESHA Food Processor microcomputer software (ESHA Corporation, Research Nutrition System, Salem, Oregon). Nutrition analysis results were not made available to participants until after the study was completed.

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ABBREVIATIONS USED IN TEXT

AHA = American Heart Association
HDL = high-density lipoprotein
LDL = low-density lipoprotein

Freshly baked muffins were distributed in opaque plastic bags to the study subjects weekly. The subjects were instructed to eat two muffins a day. They remained unaware of their group assignments throughout the study.

Twelve-hour fasting blood specimens were taken at the beginning and the end of the 28-day muffin ingestion period and were assayed for serum cholesterol, triglyceride, and HDL-cholesterol levels. Cholesterol and triglyceride levels were assayed with the Boehringer Mannheim Diagnostics/Hitachi 704 automated system.[15,16] HDL-cholesterol was assayed using an enzymic heparin-manganese chloride precipitate method.[17,18] LDL-cholesterol was estimated according to the following formula of Friedewald and co-workers[19]:

$$\text{LDL cholesterol} = \text{cholesterol} - \text{HDL cholesterol} - \text{TG}/5$$

where TG is the triglyceride level and TG/5 is an estimate of very-low-density lipoprotein.

Results

Of the original 83 medical students participating in the randomization process, 72 subjects completed the study. Eleven students were excluded for one or more of the following reasons: ingesting fewer than 75% of the formulated bran muffins; pregnancy, serious injury, or illness causing absence and requiring medication during the study (one student each); or having one or more serum specimens rated as "severely hemolyzed" by a laboratory technician not involved in the data analysis (four students). Reasons given for not eating muffins included interference with a dieting regimen (one student), increasing aversion to muffins (two students), and increased bowel frequency (one student). The 11 students not completing the study did not significantly differ from the 72 who completed the protocol in baseline lipid or dietary variables.

The 72 subjects consumed an average of 92% of the muffins provided. Tables 2 and 3 detail the lipid changes noted during the 28-day study period. These include a significant reduction in cholesterol and triglyceride levels in the oat bran group, with no change in HDL-cholesterol levels.

Several baseline variables that could have influenced the above results were analyzed to evaluate the integrity of our randomization process. Table 4 shows the results of this evaluation comparing baseline characteristics of the oat bran group with those in the pooled wheat and wheat/oat groups. No statistically significant differences were noted in baseline age, gender, exercise level, ethanol or dietary cholesterol intake rates, serum cholesterol levels, or in the percentage of muffins eaten. None of the 72 participants smoked cigarettes.

TABLE 1.—*Nutrient Characteristics of Different Muffins Used*

Nutrient	*Wheat*	*Wheat/Oat*	*Oat*
Kcal, per muffin	177.0	188.0	199.0
Total bran, grams	11.3	5.5/8.3	17.0
Dietary fiber, grams*	5.5	5.3	5.0
Total carbohydrate, grams	30.7	30.2	29.7

*One rounded tablespoon of oat bran contains about 5 grams of dietary fiber.

Discussion

De Groot and associates fed human volunteers 140 grams of rolled oats daily in the form of bread for three weeks. This resulted in an 11% reduction in serum cholesterol levels. Replacing the oat bread with normal bread restored mean serum cholesterol levels to 98% of the original levels within two weeks.[20] Several other investigators have subsequently confirmed the hypocholesterolemic properties of oat products (Table 5). A brief synopsis of each study follows.

Using metabolically controlled diets, Judd and Truswell substituted rolled oats for breakfast cereals and wheat flour in ten subjects for three weeks. Plasma cholesterol levels decreased in seven of the ten subjects, but HDL-cholesterol and triglyceride levels were unchanged. Both fecal fat and bile

TABLE 2.—*Group Changes in Serum Lipid Values**

Lipid Type	*A Wheat N=25*	*B Wheat/Oat N=28*	*A+B Pooled N=53*	*C Oat Bran N=19*
Cholesterol	0.0±3.3	0.0±4.0	0.1±2.6†	−9.5±4.3
LDL cholesterol	−2.2±4.0	−1.0±4.0	−1.5±2.8	−9.4±5.3
HDL cholesterol	1.3±1.8	−1.4±1.6	−0.1±1.2	1.3±3.5
Triglycerides	4.6±6.1	12.5±4.6†	8.7±3.8†	−6.3±5.8

HDL=high-density-lipoprotein, LDL=low-density-lipoprotein

*Mean ± standard error of the mean in mg/dl.
†$P<.05$ (one-tailed t test) when compared with the oat bran (C) group.

TABLE 3.—*Summary of Serum Lipid Changes*†*

Serum Lipid Values	*Cholesterol* C	A+B	*LDL Cholesterol* C	A+B	*Triglycerides* C	A+B	*HDL Cholesterol* C	A+B
Before	178.8	179.9	108.4	112.0	76.7	73.1	55.0	53.3
After	169.3	180.0	99.0	110.4	70.4	81.8	56.3	53.2
Change	−9.5	+0.1‡	−9.4	−1.5	−6.3	+8.7‡	+1.3	−0.1

HDL=high-density-lipoprotein, LDL=low-density-lipoprotein

*Group mean: mg/dl.
†A=wheat group, B=wheat/oat group, C=oat bran group, A+B=data from both groups pooled
‡$P<.05$ (one-tailed t test) when compared with oat bran (C) group.

acid excretion were significantly increased in subjects on the oatmeal diet, but neutral steroid excretion (including cholesterol) was unchanged. The possible effects of the oat lipid were evaluated by dietary substitution of an oil mixture (corn and nut oils) similar to oat oil for two weeks before and after the oat period. The cholesterol-reducing effects of the oat product were reduced when subjects ingested the oat oil analogue during a control period.[21]

Kirby and co-workers randomly assigned eight men to a biphasic dietary regimen, one phase differing from the other by the inclusion of 100 grams of oat bran. While no changes in the average levels of total cholesterol, LDL cholesterol, or HDL cholesterol occurred during the control (non-oat-bran-ingesting) phase, an overall 13% reduction in cholesterol levels was seen during the oat bran phase, together with a 14% decrease in the levels of LDL cholesterol and no change in the HDL-cholesterol level.[12]

Similarly, Anderson and associates showed this LDL-cholesterol-specific effect using either 100 grams (3.6 ounces) of oat bran or 4 ounces of navy or pinto beans as supplements to the metabolically controlled diets of 20 hyperlipidemic men. The 7-day control and subsequent 21-day experimental diets contained comparable amounts of cholesterol and polyunsaturated and saturated fats. An average 19% reduction in cholesterol levels was seen in both the oat bran and bean diets relative to the preexperimental diet baselines, with 23% and 24% reductions in LDL-cholesterol levels for the two groups, respectively. Improvements in HDL-/LDL-cholesterol ratios of 22% and 17% were evident in both experimental groups despite reductions in HDL-cholesterol levels of 5% and 13% for the oat bran and bean groups, respectively.[9] Long-term lipid profile benefits were noted as subsets of these same subjects continued a similar oat bran-bean diet-augmenting program during the following six months to nearly two years with sustained or actually enhanced overall cholesterol reductions.[23]

In a study similar to the present one, Storch and colleagues used oat bran and wheat bran muffins in a crossover design evaluation of healthy college students with normal baseline cholesterol values. Students received either 50 grams of oat bran or wheat bran in the form of four muffins a day for six weeks, followed by a washout period of seven days. The students then ate the other muffin type for an additional six weeks. Consuming oat bran muffins resulted in a 12% decrease in serum total cholesterol levels, while no significant changes were noted in the wheat bran muffin group.[22]

Van Horn and colleagues studied 208 healthy adult volunteers starting with a six-week washout period during which the participants followed an American Heart Association (AHA) phase I fat-modified diet (total daily fat < 30% total caloric intake, cholesterol < 250 mg per day). Participants then continued the AHA diet for an additional six weeks, isocalorically supplanting their carbohydrate intake with either 60 grams per day of oat bran (group 1), 60 grams per day of oatmeal (group 2), or no addition to the phase I AHA diet (group 3). Oat product ingestion was 39 and 35 grams per person per day for groups 1 and 2, respectively. Intake of other fiber sources was not significantly changed during the study period. Subjects in all three groups experienced a 5.2% reduction in cholesterol levels during the six weeks of the AHA diet alone. Groups 1 and 2 had further cholesterol reductions of 2.7% and 3.3%, respectively, during the second six weeks; no change in serum cholesterol levels was seen in control group 3 during this time. The reduction in cholesterol values of combined groups 1 and 2 was statistically significant when compared with that of the control group 3.[24]

When the results of the present study are included with

TABLE 4.—*Characteristics of Subjects by Study Group*

	*Oat, N=19**	*Others, N=53**
Age, years	26.1± 0.8	25.6± 0.4
Gender, % male (No.)	79 (15)	70 (37)
Exercise†	3.1± 0.2	3.0± 0.1
Ethanol, 0.1 oz/day	1.6± 0.9	1.9± 0.5
Dietary cholesterol, mg/dl	393.5±43.9	334.4±21.9
Prestudy cholesterol, mg/dl	178.8± 7.8	179.9± 4.8
% Muffins ingested	92.6± 1.8	91.6± 1.0

*Average ± standard error of the mean.
†4=maximum, 1=minimum.

TABLE 5.—*Human Studies Evaluating Oat Product Lipid Effects*

Study and Grain(s)	*Subjects, No.*	*Dose, Grams/Day*	*Days on Diet, No.*	*Prestudy Cholesterol Level, mg/dl*	*Change in Cholesterol, %*
De Groot et al, 1963[20]					
Rolled oats	21	140	21	251	−11
Judd and Truswell, 1981[21]					
Rolled oats	10	125	21	203	− 8
Kirby et al, 1981[12]					
Oat bran	8	94	10	269	−13
Anderson et al, 1984[9]					
Oat bran	10	100	21	257	−19
Storch et al, 1984[22]					
Oat bran	12	50	42	185	−12
Chen and Anderson, 1986[23]					
Oat bran/beans	10	41/145	182	257	−26
Oat bran/beans	4	41/145	693	257	−22
Van Horn et al, 1986[24]					
Oat bran	69	39	28	196	− 3
Rolled oats	69	35	28	195	− 3
This report					
Oat bran	19	17	28	179	− 5

those of the oat bran studies described above,[9,12,22,24] the oat bran dose used correlates well with the percent decrease in cholesterol values ($r = .867$). This relation can be roughly approximated by % decrease in cholesterol = $0.156 \times$ (gram oat bran/day) + 1.0.

As more data become available, it may be feasible in the future to use similar formulations to estimate cholesterol responses for a given prescription dose of an oat product.

The findings of the studies mentioned involving serum lipid subfraction analysis suggest that the hypocholesterolemic effects of oat products selectively involve reducing the LDL fraction while generally not affecting the HDL-cholesterol subfraction. These results are encouraging considering that the significant side effects seen with most currently available pharmacologic hypocholesterolemic agents are not mentioned in association with ingesting oat products in the studies reviewed here.[25]

Though the specific cholesterol-reducing mechanisms of oat bran are still being clarified,[24] evidence that it may be useful as a therapeutic adjunct is increasing. The advantages of using oat products include low cost and availability. Other benefits noted in an elderly population using oat bran meal biscuits included relief from constipation—with respect to bowel frequency, stool type, and associated pain—and a significant average weight loss.[26]

From the present study, we conclude that daily ingesting of 17 grams (two rounded tablespoons) of oat bran can significantly reduce serum total cholesterol and serum triglyceride levels in a young, healthy population. The serum cholesterol reduction appears to primarily involve the LDL subfraction. These findings reinforce those reported by others, and though the long-range health consequences of increased dietary oat product use have yet to be shown, there is mounting evidence that such dietary augmentation results in an improved, cardioprotective lipid profile.

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