Influence of Rice Bran, Oat Bran, and Wheat Bran on Cholesterol and Triglycerides in Hamsters

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ABSTRACT

The influence of stabilized or parboiled rice brans (full-fat or defatted), oat bran, or rice-wheat bran combinations on cholesterol and triglycerides was evaluated in four-week-old male, Syrian golden hamsters. The control diet (C) contained 10% cellulose and 0.5% cholesterol. Other diets were modifications of diet C that provided 10% total dietary fiber from either stabilized rice bran (RB), defatted RB, parboiled rice bran, defatted parboiled rice bran, fiber from RB and wheat bran (2:1 ratio), fiber from defatted RB and wheat bran (2:1) or oat bran. Eighty hamsters (10/treatment) were randomly fed the respective diets. After 21 days, full-fat rice bran (stabilized or parboiled) and oat bran resulted in a significantly lower elevation of plasma and liver cholesterol values compared with those fed the cholesterol control diet. Defatting rice bran resulted in a loss of its cholesterol-lowering properties. The cholesterol-lowering effect of stabilized rice bran was still apparent with a blend of 31.9% stabilized rice bran and 6.9% wheat bran.

The potential of rice bran as a food ingredient has improved considerably since commercially stabilized rice bran has become available (Randall et al 1985). How rice bran influences plasma lipids is of interest for evaluation of its nutritional properties. Lowering of serum cholesterol and triglycerides by unpolished rice in normocholesterolemic adult males is reported (Suzuki 1982). However, Miyoshi et al (1986) observed no cholesterol reductions by brown rice in normocholesterolemic healthy men. Suzuki and Oshima (1970) found reductions in human serum cholesterol with a blend of 70% rice bran oil and 30% safflower oil. Hypocholesterolemic effects in rats of rice bran oil or unsaponifiables of rice bran oil were reported by Sharma and Rukmini (1986, 1987). Seetharamaiah and Chandrasekhara (1988, 1989) found that oryzanol, isolated from rice bran oil, lowered serum cholesterol in cholesterol-fed rats. Rice bran wax was shown to lower serum cholesterol in rats (Ishibashi and Yamamoto 1980). Hypocholesterolemic activity was also demonstrated in rats with neutral detergent fiber from defatted rice bran (Ayano et al 1980) and protein isolated from rice bran (Sugano et al 1984). No influence on plasma cholesterol was observed by feeding diets containing 10% rice bran to rats (Madar 1983) or 50% rice bran (without stabilization and possibly containing hulls) to monkeys (Malinow et al 1976). Oat bran has lowered cholesterol in rats (Chen and Anderson 1979a, Chen et al 1981, Jennings et al 1988, Schinnick et al 1988) and humans (Anderson et al 1984) and achieved small additional plasma cholesterol reductions in free-living individuals consuming a low-fat diet (Van Horn et al 1986, Turnbull and Leeds 1987). Wheat bran has been shown to have varied effects, e.g., no effect (Tsai et al 1976, Chen and Anderson 1979b, Reddy et al 1980), an elevating effect on plasma cholesterol in rats (Lee et al 1979, Asp et al 1981, Unwin 1986) and in humans (Stasse-Walthius et al 1980), or a lowering effect in humans (Munoz et al 1979).

Beher et al (1963) reported that hamsters are more responsive than rats in elevation of plasma and liver cholesterol when fed a diet containing cholesterol. Spady and Dietschy (1985) reported that hamsters and man are similar in having significant levels of circulating cholesterol, intrinsically low rates of hepatic cholesterol synthesis, and in their response to diets and drugs.

The objective of this study was to evaluate the influence of full-fat and defatted rice bran, oat bran, and reduced levels of rice bran in combination with wheat bran on cholesterol and triglycerides in hamsters.

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MATERIALS AND METHODS

Four-week-old male Syrian golden hamsters (Simonsen Labs., Gilroy, CA) were fed for 21 days. Animals were kept individually (20–22°C, 60% relative humidity) in wire bottom cages, with 12-hr light and dark cycles. Feed consumption was measured twice weekly, and the animals were weighed once a week.

Cereal brans used in this study were stabilized rice bran (extruded at 130°C; Rice Growers Association of California, Sacramento, CA) and parboiled rice bran (Uncle Ben's Inc., Houston, TX); defatted stabilized and defatted parboiled rice bran (hexane-extracted in a Soxhlet apparatus, desolventized and toasted at 110°C); wheat bran (standard reference hard red, American Association of Cereal Chemists, St. Paul, MN) and oat bran (oat bran cereal, Quaker Oats Co., Chicago, IL). Dietary fiber composition of the cereal products used in diet formulations is shown in Table I. Diet ingredients were analyzed for total and soluble dietary fiber (Prosky et al 1988), crude fat (method 7.056, AOAC 1980), and nitrogen (Kjeldahl procedure). Composition of the diets is shown in Table II. The control diet (C) contained 10% cellulose and 0.5% cholesterol. Other diets were modifications of diet C replacing the cellulose with 10% total dietary fiber from either stabilized rice bran (RB), defatted stabilized rice bran (defatted RB), parboiled rice bran (PB), defatted parboiled rice bran (defatted PB), fiber from RB and wheat bran (RWB, 2:1 ratio, respectively), fiber from defatted RB and from wheat bran (2:1 ratio, defatted RWB), or oat bran (OB). The diets were formulated to be isonitrogenous and contained 10% total dietary fiber and 10.7% fat. All diets were stored at 4°C. Eighty hamsters were assigned by selective randomization to eight groups of 10 each and fed the respective diets ad libitum.

After 21 days, the animals were fasted for 16 hr and anesthetized with CO_2; blood was drawn by cardiac puncture and livers were collected. Plasma samples were analyzed for cholesterol and triglycerides using enzymatic colorimetric methods (Gilford diagnostic kits 214346 and 232422, respectively, Gilford Systems, Oberlin, OH). Whole livers were homogenized in ethanol and total lipids were extracted from aliquots containing 1 g of liver using the procedure of Folch et al (1957). Aliquots of liver homogenate were centrifuged, the supernatant evaporated in a vacuum concentrator, and the liver residue homogenized in 10 ml of chloroform/methanol, 2:1 (C/M), for two 20-sec intervals with a Polytron homogenizer (Brinkmann Instruments, Westbury, NY) at a power setting of 6. Homogenate was filtered through a glass fiber filter (GF/A 180042, Whatman, Hillsboro, OR) into a 25 × 150 mm screw-cap tube; liver residue and filter were rehomogenized in 10 ml of C/M, filtered as before, and the residue rinsed with 5 ml of C/M. The extract was combined with the residue from the evaporated ethanol supernatant and washed with 4.0 ml of $CaCl_2$ solution (0.05%), and the total volume (X) was marked. After centrifugation, the upper phase was discarded and the lower phase washed with sufficient chloroform/methanol/water, 3:48:47 (v/v), to obtain volume X. The upper phase was discarded after centrifugation and the lower phase transferred to a volumetric flask and brought to 25 ml with chloroform/methanol, 86:14 (v/v). Total liver cholesterol was determined by an enzymatic colorimetric method (Sigma diagnostic kit no. 352, Sigma Chemical Co., St. Louis, MO) with the addition of Triton X-100 as solubilizing agent (Carlson and Goldfarb 1977). Liver triglycerides were determined by a colorimetric method (Sigma kit no. 405), after evaporating aliquots of extract under nitrogen and redissolving in C/M (2:1, v/v). All samples were analyzed

TABLE I
Composition of Cereal Brans Used in Diet Formulations (mean ± SEM)

Ingredient	Total Dietary Fiber[a] (% dm)	Soluble Dietary Fiber[a] (% dm)	Nitrogen (% dm)	Fat (% dm)	Moisture (%)
Rice bran	20.9 ± 0.1	1.9 ± 0.2	2.4 ± <0.1	22.4 ± 0.2	5.9
Defatted rice bran	27.0 ± 0.1	1.9 ± 0.2	3.0 ± <0.1	0.2 ± <0.1	7.1
Parboiled rice bran[b]	31.5 ± 0.2	2.4 ± 0.2	3.2 ± <0.1	29.6 ± 0.1	8.8
Defatted parboiled rice bran[c]	51.2 ± 0.2	2.9 ± 0.2	4.3 ± <0.1	0.5 ± <0.1	6.1
Oat bran	18.6 ± 0.2	8.0 ± 0.4	3.6 ± <0.1	7.7 ± <0.1	10.2
Wheat bran	48.4 ± 0.1	2.7 ± 0.3	2.6 ± <0.1	4.7 ± 0.1	8.1

[a] Analyzed by procedure of Prosky et al (1988). Expressed in percent dry matter (% dm).
[b] Higher dietary fiber of parboiled rice bran is due to cleaner bran separation after parboiling.
[c] Total dietary fiber was increased in amount (6.6%) by the defatting process, which was confirmed by repeat analysis.

TABLE II
Composition of Diets (% dry matter)

Ingredients	Control	Rice Bran[a]	Defatted Rice Bran[a,b]	Parboiled Rice Bran[c]	Defatted Parboiled Rice Bran[b,c]	Rice Bran Fiber[a] + Wheat Bran Fiber[d] (2:1)	Defatted Rice Bran Fiber[a,b] + Wheat Bran Fiber[d] (2:1)	Oat Bran[e]
Rice bran	0.0	47.8	37.1	31.8	19.6	31.9	24.7	0.0
Oat bran	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.7
Wheat bran	0.0	0.0	0.0	0.0	0.0	6.9	6.9	0.0
Cellulose	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Corn starch	53.8	34.3	34.2	48.1	49.9	38.7	38.6	25.9
Casein	20.0	12.4	12.6	13.3	14.4	13.8	14.0	8.3
Corn Oil	10.7	0.0	10.6	1.3	10.6	3.2	10.3	6.5
Mineral mix[f]	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Vitamin mix[f]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
DL-Methionine	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Choline bitartrate	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Cholesterol	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

[a] Stabilized rice bran (Rice Growers of America, Sacramento, CA).
[b] Hexane extracted in a Soxhlet apparatus, desolventized and toasted at 110°C.
[c] Parboiled rice bran (Uncle Ben's, Inc. Houston, TX).
[d] AACC hard red reference wheat bran (American Association of Cereal Chemists, St. Paul, MN).
[e] Oat bran cereal (The Quaker Oats Co., Chicago, IL).
[f] American Institute of Nutrition, 1980.

in triplicate and values determined from standard curves obtained by running National Bureau of Standards reference materials for cholesterol and triglycerides through the procedure as described for the samples. Data were statistically analyzed using Duncan's new multiple range test (Steel and Torrie 1960).

RESULTS

Initial weights and final weights after 21 days were similar in all groups except for the PB group, which had weights and gains similar to those of the defatted PB group but significantly less than all other groups (Table III). Hamsters fed the PB diet consumed significantly less feed than any other group. Liver weights were significantly lower in RB and PB than in C, defatted RB, or defatted PB groups; liver weights in PB were also significantly lower than defatted RWB and OB groups.

Hamsters fed the various bran diets had significantly lower plasma cholesterol than those fed the control diet, except those fed defatted RB or defatted PB had plasma cholesterol values similar to those fed diet C. In RB or OB groups, plasma cholesterol values were significantly lower than defatted RB or defatted PB groups. Liver cholesterol (in milligrams per liver) values were significantly lower in all bran-fed hamsters than in those fed diet C, except for defatted PB or defatted RWB groups. Hamsters fed RB or OB diets had significantly lower liver cholesterol than those fed other bran diets. In addition, liver cholesterol values for the RB group were also significantly lower than for the OB group.

Plasma triglycerides were not significantly influenced in animals fed any of the diets (range 933–1,510 mg/dl). Hamsters fed bran diets had liver triglyceride values (milligrams per liver) similar to those fed the control diet, except for the defatted RB group, where values were significantly lower than C group but similar to all other bran groups.

DISCUSSION

The plasma and liver cholesterol-lowering effect of the OB diet in hamsters is consistent with the results of other studies with rats (Chen and Anderson 1979a,b; Chen et al 1981; Shinnick et al 1988; Jennings et al 1988). Similar effects on plasma cholesterol with oat bran have been reported in humans (Anderson et al 1984). Our results showed that a diet containing 54% oat bran that contained 4.3% soluble fiber (OB) was effective in lowering plasma and liver cholesterol. Elsewhere, a diet containing 5% oat gum was shown to lower cholesterol in rats (Jennings et al 1988).

Both full-fat rice brans (stabilized or parboiled, 48 and 32% of the diet, respectively) and oat bran (54%) resulted in significantly lower plasma and liver cholesterol compared with the control. A diet containing 32% stabilized rice bran in combination with 7% wheat bran (RWB) also lowered plasma and liver cholesterol. Some of the effect of the PB group may be due to significantly lower feed (and therefore, cholesterol) intake by this group. Although group defatted RWB showed a plasma cholesterol lowering effect similar to that of RWB, this was likely due to a very low plasma cholesterol value (162 mg/dl) for one animal that did not eat the defatted RWB diet for the last three days of the feeding period. Excluding that animal, the mean plasma cholesterol for defatted RWB would be 350 instead of 331 mg/dl, resulting in a nonsignificant effect for the defatted RWB diet. Furthermore, liver cholesterol values for hamsters fed the defatted RWB diet were similar to those fed the control diet.

Defatted rice bran (RB or PB) diets were ineffective in lowering plasma cholesterol compared with the control diet. Defatted RB was effective in lowering liver cholesterol; however, values for defatted PB were similar to the control.

A lowering effect on serum cholesterol in humans by unpolished rice has been reported (Suzuki 1982). However, Miyoshi et al (1986) observed no cholesterol reductions attributable to brown rice in healthy men with normal cholesterol levels. No effect on plasma cholesterol was observed in monkeys fed a diet containing 50% rice bran (Malinow et al 1976). However, the rice bran used was of inferior quality, containing a large quantity of rice hulls, as judged from inspection of the proximate analysis. Elsewhere, a diet containing 10% rice bran had no effect upon serum cholesterol in rats (Madar 1983). In neither of these studies was the bran stabilized, and diets were very low in cholesterol (from 0 to ≤0.1%). Ayano et al (1980) also observed no significant plasma cholesterol reduction with 5% defatted rice bran fiber in rats; however, plasma cholesterol was significantly reduced by a diet containing 5% of the neutral detergent fraction isolated from defatted rice bran. Recently, Nicolosi et al (1989) reported a 40% reduction in total and low-density lipoprotein cholesterol in monkeys fed a diet in which rice bran oil made up 35% of the calories.

In the present study, diets containing stabilized or parboiled rice bran at a 10% total dietary fiber level (which contained 0.8–0.9% soluble fiber) lowered cholesterol in hypercholesterolemic hamsters. After defatting these rice brans, and feeding at the same fiber level (0.6–0.7% soluble fiber), no lowering of cholesterol was observed. The cholesterol-lowering properties of rice bran thus appear to be associated with the oil fraction rather than total or soluble dietary fiber.

TABLE III
Effect of Bran Diets on Weight Gain, Feed Intake, and Plasma and Liver Cholesterol and Triglycerides in Hamsters[a]

Diet[b]/ % Dietary Fiber (total, soluble)	Final Weight (g)	Weight Gain (g/day)	Feed (g/day)	Liver Weight (g)	Cholesterol			Triglycerides		
					Plasma (mg/dl)	Liver (mg/liver)	Liver (mg/g)	Plasma (mg/dl)	Liver (mg/liver)	Liver (mg/g)
Control (10, 0.0)	122.2±3.2 a	2.9±0.2 a	9.3±0.3 a	7.0±0.3 a	401.8±15.9 a	393.7±16.7 a	56.6±1.5 a	1,510±137 a	45.4±3.9 a	6.5±0.5 ab
Rice bran (10, 0.9)	118.6±3.5 a	2.8±0.2 a	9.4±0.3 a	5.8±0.3 bc	274.2±13.7 e	180.7±10.1 d	31.2±1.5 e	933±126 a	36.5±3.0 ab	6.3±0.5 ab
Defatted rice bran (10, 0.7)	125.8±3.0 a	3.1±0.1 a	9.9±0.3 a	7.0±0.3 a	353.3±16.2 abc	311.4±15.8 b	44.6±1.2 cb	1,429±199 a	32.6±2.3 b	4.6±0.2 c
Parboiled rice bran (10, 0.8)	108.4±2.8 b	2.3±0.1 b	8.4±0.2 b	5.6±0.2 c	302.3±18.6 cde	298.3±13.9 b	53.2±2.3 ab	1,000±142 a	41.8±5.2 ab	7.5±1.0 a
Defatted parboiled rice bran (10, 0.6)	117.3±3.4 ab	2.7±0.2 ab	9.8±0.2 a	6.7±0.3 a	383.4±21.3 ab	379.0±10.0 a	56.9±1.5 a	1,427±248 a	43.4±4.3 ab	6.4±0.5 ab
Rice bran + wheat bran fiber (2:1) (10, 0.8)	123.7±3.2 a	3.0±0.1 a	9.8±0.2 a	6.4±0.2 abc	334.3±11.0 bcd	310.7±11.7 b	48.6±1.7 bc	1,240±113 a	39.6±1.8 ab	6.2±0.4 ab
Defatted rice bran + wheat bran fiber (2:1) (10, 0.7)	121.1±4.2 a	2.9±0.2 a	9.8±0.3 a	6.6±0.3 ab	330.9±26.8 bcd	358.1±15.4 a	55.4±3.3 a	1,273±230 a	37.5±4.2 ab	5.9±0.9 abc
Oat bran (10, 4.3)	126.4±3.6 a	3.1±0.2 a	9.2±0.3 a	6.5±0.3 ab	294.0±16.7 de	257.9±14.4 c	39.8±1.2 d	1,156±218 a	33.8±4.0 ab	5.2±0.6 bc

[a] Initial weights were similar among all groups (mean ± SEM, 60.5 ± 0.7). Values are mean ± SEM; $n = 10$. Means within a column with different letters differ significantly ($P < 0.05$)
[b] All diets contained 0.5% cholesterol.

The potential cholesterol-lowering components of rice bran include, but may not be limited to, the degree of oil unsaturation, unsaponifiables in the oil, sterols (oryzanol, cycloartenol, β-sitosterol), hemicellulose, and protein. Evidence already exists for hypocholesterolemic effects of rice bran oil (Suzuki and Oshima 1970, Sharma and Rukmini 1986, Raghuram et al 1989), unsaponifiable material in the oil (Sharma and Rukmini 1987), oryzanol (Seetharamaiah and Chandrasekhara 1988, 1989), β-sitosterol (Beher and Anthony 1958), hemicellulose (Ayano et al 1980, Aoe et al 1989), wax (Ishibashi and Yamamoto 1980), and protein (Sugano et al 1984).

All bran-fed hamsters had plasma and liver triglyceride values similar to the control except for the defatted RB group, where liver values were significantly lower than the control. With this exception, neither plasma nor liver triglycerides were influenced by any of the cereal brans tested. Lower liver values for the defatted RB group were not supported by the plasma data, since plasma triglyceride values were higher for this group than for any other bran-fed group and they were not significantly different from the control group. Plasma hypertriglyceridemia (933–1,510 mg/dl) observed in this study may be due to hydroxymethylglutaryl-coenzyme A (HMG-CoA) reductase inhibition in hamsters fed cholesterol diets. Singhal et al (1983) observed that addition of cholesterol (0.15 or 1.0%) to hamsters' diets lowered hepatic HMG-CoA reductase activity by 90%. Amin et al (1988) reported that HMG-CoA reductase inhibition results in hypertriglyceridemia in hamsters, elevating plasma triglycerides from 318 to 2,752 mg/dl.

In summary, under the conditions of this study, rice bran (stabilized or parboiled) and oat bran resulted in significantly lower plasma and liver cholesterol values when fed to hypercholesterolemic hamsters. Replacing one-third of the stabilized rice bran fiber with wheat bran fiber also resulted in lower plasma and liver cholesterol. Defatting the two rice brans caused a loss in the hypocholesterolemic properties.

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