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Serum Lipid-Lowering in Rats Fed with High Dietary Fiber from Cereal and Nata De Coco

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ABSTRACT

This study was conducted to evaluate the different serum triglyceride and cholesterol-lowering effects of five kinds of dietary fiber diet in experimental rats. Source and percentage of dietary fiber in five experimental diets were 2.86 from unpolished rice, mung bean, sweet corn and nata de coco in diet 1 and 2, 7.76 from apple pectin in diet 3, 10.39 from cellulose in diet 4, 0.58 in diet 5. Each diet was composed of soy oil, salt mixture, vitamin mixture, corn starch and sucrose. Cholesterol contents were 13.00, 11.40, 14.20, 14.10 and 13.50 mg/100 g in diet 1, 2, 3, 4 and 5, respectively. Those five experimental diets were fed to 3-wk-old weanling male Sprague-Dawley rats for 4 weeks. After 4 weeks, serum triglyceride levels were significantly lower in rat fed with diet 2 compared with those fed with diet 3 and diet 4. Serum cholesterol levels were not significantly different among the rats fed with five diets except those rats fed with diet 2 showed significantly higher serum cholesterol than rats fed with diet 5. The data indicate that dietary fiber diet 2 containing 6% unpolished rice, 18% mung bean, 30% sweet corn and 40% nata de coco significantly reduced serum triglyceride in the experimental rats.

Key words: dietary fiber, cholesterol, triglyceride, rats, nata de coco

INTRODUCTION

Several dietary fibers significantly decrease serum cholesterol concentration in human and thereby reduce the risk for coronary heart disease (Anderson e*t al*., 1990). Rats fed with psyllium (rich in soluble fiber) had the lowest serum and liver cholesterol concentrations. Rats fed with other soluble fiber-rich fibers such as oat gum, guar gum and pectin also had significantly lower serum and liver cholesterol concentrations than rats fed with cellulose. Rats fed with rice bran, an insoluble fiber source, had significantly higher liver cholesterol, lower serum triglyceride concentration and body weight gains than cellulose-fed rats (Anderson *et al.*, 1994). The serum triglyceride response was lower ($P \leq 0.05$) in the presence of oat bran, wheat fiber, or wheat germ while chylomicron triglyceride was reduced with wheat fiber (Cara *et al*., 1992). Serum triglyceride of hypercholesterolemic men was decreased by 10% in oat-bran and wheat bran feeding groups but the decrease was only significant ($p < 0.04$) those who have taken wheat bran. Only oat-bran significantly reduced total cholesterol and other atherogenic lipoprotein fraction independent of other dietary changes. Oat-bran diets supplied 34 g total dietary fiber and 13.4 g soluble fiber. The wheat-bran diet was designed to provide 34 g total dietary fiber and 7.8 g soluble fiber (Anderson *et al*., 1991 and Kashtan *et al*., 1992).

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Several physiological responses, such as lowering of plasma cholesterol level, modification of the glycemic response, improving large bowel function, and lowering nutrient availability, have been associated with isolated fiber fractions or diets rich in fiber-containing foods. In mediating these responses, it is clear that the physical properties of dietary fibers affect the function of gastrointestinal tract and influence the rate and site of nutrient absorption (Gallaher and Schneeman, 1996).

Plant raw materials such as cereal and legume, sweet corn, unpolished rice, mung bean and nata de coco are sources of dietary fiber and plenty in Thailand. They are produced in the form of health food. The purpose of this study is to compare the serum lipid lowering effect in the experimental rats fed with prepared dietary fiber health food from sweet corn, unpolished rice, mung bean, nata de coco with those fed with health food from Bangkok market.

MATERIALS AND METHODS

Animals Three-week-old male Sprague-Dawley rats were used. The rats with a mean initial weight of 50-60 g, mean body weight within group not more than 10 g and between group not more than 5 g were housed individually in metabolic cages. They were maintained in a controlled environment at 20-22°C, 60% relative humidity and with a 12-h light-dark cycle. Animals were randomly selected to five groups. Each group were ten animals. They were provided with dietary fiber test diets and water ad libitum for 28-d feeding period. Food consumption was measured daily. Animals and feces were weighed weekly.

Diets and preparation of dietary fiber health food Agricultural plant products : unpolished rice, mung bean, sweet corn and nata de coco, were weighed, boiled and mixed together. The products contained 6% unpolished rice, 18% mung bean, 36% sweet corn, 40% nata de coco. Water was added into the mixture, blended with electric mixer until homogenous. Food was dried by Drum Dryer with the roller temperature at 135°C at 50 s/round speed, and clearance of 0.15 mm. The dried food was made into powder by Pin Mill.

Apple pectin together with cellulose and casein were bought from supermarket in Bangkok, Thailand. The composition of five raw material health food is shown in Table 1. Proximate analysis, dietary fiber and cholesterol content of five raw material health foods from dietary fiber source were determined (Table 2).

Five experimental diets were prepared from dietary fiber in the form of health foods by AOAC method (AOAC, 1998). Those foods were composed of 10 ± 0.3% protein, 8% soy oil, 5% mineral mixture, 1% vitamin mixture, 1% cellulose, 5% moisture, 35% sucrose and 35% corn starch (Table 3). The composition of five experimental diets, proximate analysis, dietary fiber and cholesterol

Table 1 Composition of raw material health foods (sample) before preparing the experimental diet.

Formula (Sample)	Unpolished rice (g /100 g)	Mung bean (g/100 g)	Sweet corn (g /100 g)	Nata de coco (g /100 g)	Powder milk (g /100 g)	Sucrose (g /100 g)
1	3.3	9.9	19.8	22.0	25.0	20.0
2	6.0	18.0	36.0	40.0	-	-
3	Apple pectin					
4	Cellulose					
5	Casein					

content were determined (Table 4).

Sample collection and analysis After 28 d, the experimental diets were withheld from experimental rats for 16-h. The experimental rats were anesthetized with ether. Blood was drawn using cardiac puncture into test tube and centrifuged at 1000×g for 10 min to obtain serum. Serum samples were analyzed using enzymatic colorimetric procedures. Proximate analysis and corrected protein efficiency ratio (PER) were determined by AOAC

Table 2 Proximate analysis, dietary fiber and cholesterol content of five raw material health foods (sample).

Formula (Sample)	Moisture (g / 100 g)	Protein (g / 100 g)	Fat (g / 100 g)	Ash (g / 100 g)	*SDF (g / 100 g)	**IDF (g / 100 g)	Cholesterol (mg / 100 g)
1	7.81	18.11	4.67	3.34	1.88	4.69	0.00
2	10.93	17.61	4.95	2.82	1.47	9.66	0.00
3	7.51	0.87	2.80	0.67	18.89	37.08	0.00
4	8.90	0.19	0.77	0.24	0.85	88.37	0.00
5	11.31	82.45	0.50	3.62	1.18	4.58	21.70

* Soluble dietary fiber
** Insoluble dietary fiber

Table 3 Composition of five experimental diets.

Diet	Sample (g /10 kg)	Soy oil (g /10 kg)	Mineral mixture (g/10 kg)	Vitamin mixture (g/10 kg)	Water (g/10 kg)	Corn starch (g/10 kg)	Sucrose (g/10 kg)	Cellulose (g/10 kg)	Casein (g/10 kg)
1	5522	542	316	100	69	1857	1857	-	-
2	5678	519	340	100	-	2008	2008	-	-
3	2019	738	443	100	211	2638	2638	-	1213
4	1266	784	453	100	250	2967	2967	-	1213
5	-	794	456	100	363	3522	3522	30	1213

Table 4 Proximate analysis, dietary fiber and cholesterol content of five experimental diets.

Diet	Moisture (g /100 g)	Protein (g /100 g)	Fat (g /100 g)	Ash (g /100 g)	*SDF (g /100 g)	**IDF (g /100 g)	Cholesterol (mg /100 g)
1	6.64	9.82	7.76	4.35	0.26	2.60	13.00
2	8.35	9.79	7.78	4.13	0.26	2.60	11.40
3	6.49	10.20	10.44	4.22	1.55	6.21	14.20
4	6.56	10.20	10.61	4.18	0.27	10.12	14.10
5	6.30	10.33	10.64	4.29	0.55	0.03	13.50

* Soluble dietary fiber
** Insoluble dietary fiber

method (AOAC,1998). Cholesterol content in foods and diets were measured using gas chromatography (AOAC, 1998). Dietary fiber content was analyzed using enzymatic-gravimetric method (AOAC, 1998).

Statistical analysis Data were statistically analysed using Analysis of Variance (ANOVA) and Duncan's New Multiple Range Test. A value of $P< 0.05$ was considered significant.

RESULTS

Serum triglyceride and cholesterol Serum triglyceride levels were significantly lower in rats fed with experimental diet from health food composed of nata de coco, unpolished rice, sweet corn and mung bean than those fed with experimental diet from health food composed of apple pectin and cellulose. Serum cholesterol levels were not significantly different in rats fed with experimental diet from health food composed of nata de coco, unpolished rice, sweet corn and mung bean compared with those fed with experimental diet from health food composed of apple pectin and cellulose (Table 5).

Body weight, food intake, fecal weight and PER The mean initial weight of all treatments was similar but the mean final body weight of the rats fed with experimental diet 2 was significantly lower than the other four treatments. The mean food intake of rats given experimental diet 2 was similar to those fed with experimental diet 5 but significantly lower than those fed the other three experimental diets. The mean fecal weight was significantly different in rats fed with five kinds of experimental diets. Corrected protein efficiency ratio (PER) of rats fed with experimental diets 2 was significantly the lowest compared with those fed with the other four experimental diets (Table 6).

DISCUSSION

The mean of food intake in rats fed with the experimental diet 2 was the lowest so the mean of final body weight (Fordyce-Baum *et al*., 1989 and Hara *et al*., 1994) and protein efficiency ratio were significantly lower than those fed with the other experimental diets. Rats fed with experimental diet 5 showed significantly the lowest mean of fecal weight because this diet consisted of only 0.58% total dietary fiber (Kelsay *et al*., 1978). Eleven from twenty two obese women treated with sweet basil seed extract for 1 y decreased their body weight for 1 - 4 kg (Mesomya,1995).

Health food from dietary fiber produced in this study, composed of 40% nata de coco, 6% unpolished rice, 30% sweet corn and 18% mung bean (diet 2) gave the best lowering effect of serum triglyceride in experimental rats compared with those fed with apple pectin (diet 3) and cellulose (diet 4), even though the total dietary fiber content in diet 2 (2.86%) was lower than that in apple pectin

Table 5 Serum triglyceride and cholesterol levels in rats fed with five experimental diets.

Experimental diet	Triglyceride (mg / dl)	Cholesterol (mg / dl)
1	105.8 ± 17.84^{ab}	132.1 ± 22.12^{ab}
2	88.0 ± 20.30^{a}	138.4 ± 13.33^{b}
3	169.5 ± 58.94^{c}	127.4 ± 10.03^{ab}
4	134.8 ± 43.58^{b}	130.4 ± 13.18^{ab}
5	120.8 ± 24.16^{ab}	123.4 ± 11.87^{a}

Values are means ± SD, N = 10. Values in a column with different superscripts are significantly different, $p < 0.05$.

Table 6 Body weight, food intake, fecal weight and corrected protein efficiency ratio (PER) of rats fed with five experimental diets.

Experimental diet	Initial weight (g)	Final weight (g)	Food intake (g / rat / day)	Fecal weight (g / rat / day)	PER
1	56.88	171.49 ± 10.78^{b}	14.40 ± 3.31^{b}	9.22 ± 2.21^{b}	2.36 ± 0.07^{b}
2	56.67	127.51 ± 11.64^{a}	12.09 ± 2.52^{a}	10.75 ± 2.28^{c}	1.81 ± 0.07^{a}
3	57.13	184.11 ± 9.86^{b}	14.44 ± 3.73^{b}	16.89 ± 4.45^{d}	2.54 ± 0.09^{c}
4	57.21	179.19 ± 17.25^{b}	14.14 ± 3.71^{b}	18.29 ± 5.46^{e}	2.48 ± 0.20^{c}
5	57.11	173.37 ± 19.40^{b}	12.96 ± 3.46^{a}	5.08 ± 1.44^{a}	2.50 ± 0.08^{c}

Values are means ± SD, N = 10. Values in a column with different superscripts are significantly different, $p < 0.05$.

diet 3 (7.76%) and that in cellulose diet 4 (10.39%). Serum cholesterol levels in the rats fed with three experimental diets (diet 2, 3, 4) were not significantly different because it may be nearly the same cholesterol content in the experimental diet 2, 3, 4; 11.40, 14.20 and 14.10 mg/100 g respectively.

Although the percentage of soluble fiber to total dietary fiber in diet 2, 3, 4 were 9.09, 19.97, 2.60 respectively, serum cholesterol levels in rats were not significantly different which was contrast with the study of Anderson *et al*. (1994). They studied in ten dietary fibers in male Sprague-Dawley rats for 3 wk. The results showed that the rat fed with psylliums which consisted of high soluble fiber had the lowest serum cholesterol concentrations. Rats fed with the other soluble fiber such as oat gum, guar gum and pectin also had significantly lower serum cholesterol concentrations than rats fed with cellulose. They indicated that feeding dietary fibers rich in soluble fiber produced lower serum cholesterol concentrations than does feeding commonly available sources of water – insoluble fiber but in our study, different content of soluble and insoluble fiber in experimental diets had no effect on serum cholesterol levels in the experimental rats.

According to Anderson *et al*. (1991), the serum triglyceride levels significantly ($P<0.04$) decreased by 10% in hypercholesterolemic men consuming wheat bran at 40 g/day. Neither pectin, cellulose, nor lignin significantly altered serum total cholesterol, triglycerides, high density lipoprotein cholesterol, or the ratio of high-density lipoprotein to total cholesterol in healthy normolipidemic subjects over four weeks (Hillman *et al*., 1985). The results of our study showed the serum triglyceride lowering effect of health food product from 40% nata de coco, 6% unpolished rice, 36% sweet corn and 18% mung bean which was highly insoluble fiber. So our results may indicate that the insoluble fiber in this health food product significantly reduced serum triglyceride in experimental rats.

CONCLUSION

The experimental diet with the lowest cholesterol centent (11.40 mg/100 g) was produced from 40% nata de coco, 6% unpolished rice, 36% sweet corn and 18% mung bean. This diet significantly lower the serum triglyceride level in experimental rats than those fed with the experimental diet having apple pectin and cellulose even though the percentage of total dietary fiber (2.86 g/100 g) was lower than the other two experimental diets (apple pectin and cellulose) (7.76, 10.39 g/100 g, respectively) but having no serum cholesterol lowering effect. The results imply that

the insoluble fiber in high dietary fiber food from 40% nata de coco, 6% unpolished rice, 36% sweet corn, 18% mung bean may reduce serum triglyceride in the experimental rats. This high dietary fiber food could be applied for health food which helps in treatment and protection of hypertriglyceridemic patients and healthy human.

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