Effects of health food from cereal and nata de coco on serum lipids in human

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Abstract

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The purpose of this study was to evaluate cereals and nata de coco supplementation on the lipid status in 22 subjects with hyperlipidemia. Subjects consisted of eleven men and eleven women aged 32-75 years, and had serum total cholesterol (TC) level of ≥ 5.2 mmol/L, serum total triglyceride (TG) level of ≥ 1.7 mmol/L and low density lipoprotein-cholesterol (LDL-c) level of ≥ 3.4 mmol/L. The study consisted of four weeks of control and 20 weeks of supplementation period. The subjects were given 15 g of the supplement twice daily for 20 weeks. The daily 30 g supplement consisted of unpolished rice, hulled mung bean, sweet corn, and nata de coco and provided 122.6 kcal, 5.5 g of protein, 0.5 g of fat, 24.1 g of carbohydrate and 2.7 g of dietary fiber. After 20 weeks, the subjects were divided into two groups, according to their dietary compliance, group A: $\geq 90\%$ compliance, and group B: $< 90\%$ compliance with the assigned supplement intake. There were 15 subjects in group A, and 7 in group B. Results showed that in group A the mean TG levels at weeks 4, 8,

and 16 were significantly different (P<0.05), but no significant differences were observed in TC, LDL-c and HDL-c except that TC level at week 16 was significantly lower than that at week 0 (P<0.05). Thus, the results appeared to indicate that health food from unpolished rice, hulled mung bean, sweet corn and nata de coco may reduce the serum TG and TC in hyperlipidemic patients.

Key words : sweet corn, nata de coco, hyperlipidemic, unpolished rice, mung bean

Dietary fiber (DF) is the portion of plant cells that cannot be digested by human alimentary enzymes. It cannot be absorbed from small intestine but are partly hydrolyzed by bacteria in the colon. In general, dietary fiber can be divided into 2 types according to its solubility: water soluble dietary fiber and water insoluble dietary fiber. Each type has different physiological effect. Water soluble dietary fiber is associated with the reduction of blood cholesterol and intestinal absorption of glucose, whereas water insoluble dietary fiber is related to both water absorption and intestinal regulation. Several studies have suggested that a high intake of dietary fiber from cereals is associated with a low risk of coronary heart disease (CHD) (Anderson *et al*., 1994).

Recently, the eating pattern of Thai people has changed towards greater consumption of instant foods and convenient western diets. These diets include fast food and prepared food such as hamburger, pizza, fried chicken and bakery products. The reason for their popularity is the ease of preparation and consumption in comparison to the long hours of preparation required by traditional Thai food. The changing consumption pattern can result in nutrition problems since these foods often provide high fat, sugar, refined carbohydrates and energy, but low dietary fiber. According to one study on the dietary fiber consumption of Thai adolescents in Bangkok, the average intake of dietary fiber in males was only 7.3 g/day (mostly from grains) and that in females was only 8.8 g/day (mostly from fruits). This study showed that the dietary fiber intake of adolescents was lower than the recommended amount (Sansanee, 1990).

Numerous health organizations have suggested increasing the consumption of dietary fiber, with specific recommendations of 25-30 g/day (Thai RDI Committee, 1989). It is difficult to meet daily requirements because fruits and vegetable, which are the main sources of dietary fiber for Thai people, contains only 1-3% dietary fiber, therefore, large consumption is needed. The high fiber products, which include a number of high fiber ingredients such as wheat bran, oat bran, corn bran, cellulose, etc., may be an alternative. However, most of these ingredients are imported, some of which may be expensive and not be appropriate for Thai tastes (Santana, 1994). Several Thai agricultural products have the potential for use as dietary fiber sources and, therefore, should be investigated.

There are many sources of dietary fiber, e.g. cereals and legumes, sweet corn, unpolished rice, mung bean and nata de coco, which may be used as fiber supplement. Legume intake has been associated with the reduction of blood cholesterol (TC) and triglyceride (TG). Jenkins *et al*. (1983) assessed the effect of leguminous seeds in the dietary management of 7 males with hyperlipidemia. All subjects were given approximately 140 g of dried beans daily to replace other sources of starch in their diet over a 4-month period. The energy intake and body weight of the subjects were held constant. The results revealed that high-legume diet significantly reduced serum triglyceride and cholesterol levels, but LDL-C remained unaltered.

Nata de coco is an organic high dietary fiber food product, produced by bacterial fermentation of coconut water. It is high in cellulose, low in fat and calories and contains no cholesterol. It has been thought capable of controlling weight, and protecting against diverticular disease and cancer of the colon and rectum.

Mesomya *et al*. (2002) have developed a health food product, using cereals, legumes, sweet corn, unpolished rice, mung bean and nata de coco

as sources of dietary fiber. They compared the serum lipid lowering effect of the product on experimental rats with health food from Bangkok market. The results showed the product derived from 6% unpolished rice, 18% mung bean, 36% sweet corn and 40% nata de coco significantly lowered the serum triglyceride level in the rats.

To take the research a step further, this study was conducted to evaluate the effect of cereals and nata de coco supplementation on the serum lipid level of the patients with hyperlipidemia. The result from this study could be used as a dietary guideline for hyperlipidemic patients and the general public who have problems with serum lipid level.

Materials and Methods

Subjects

The 22 subjects, consisting of 11 men and 11 woman with hyperlipidemia, were chosen from the patients at the Nutritional Clinic, Department of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand, and the Medical and Health office, Electricity Generating Authority of Thailand (EGAT), Nonthaburi, Thailand.

The criteria for hyperlipidemia were based on serum TC level of $\geq$ 200 mg/dL ($\geq$ 5.2 mmol/L), serum TG level of $\geq$ 150 mg/dL ($\geq$ 1.7 mmol/L), and LDL-C level of $\geq$ 130 mg/dL ($\geq$ 3.4 mmol/L). The study excluded subjects with secondary causes of hyperlipidemia e.g. hypothyroidism, nephrotic syndromes, diabetes, and glucocorticoid therapy. No subjects received hypocholesterolemic medication within three months before or during study. All subjects were requested to participate in this study for 24 weeks.

Experimental design

Each subject was expected to participate in a 24 weeks study consisting of 4 weeks (wk -4 -

wk 0) of control and 20 weeks (wk 0 - wk 20) of supplementation periods (Figure 1).

Before starting the trial in the control period, all of the subjects were given dietary counseling and education in what constituted an appropriate diet. Throughout the study the subjects were instructed to consume diets with 15% of energy derived from protein, 30% from fat, and 55% from carbohydrate. Their cholesterol intake was restricted to less than 300 mg/day. After the control period, the subjects whose serum lipid was reduced to a normal range were excluded. The remainders must have a high level of serum lipid (TC > 200 mg/dL, TG > 150 mg/dL and LDL-C > 130 mg/dL). After 20 weeks, the subjects were classified into two groups according to their dietary compliance. Group A complied with the assigned supplement intake $\geq$ 90% of the time, and group B < 90% of the time.

During the supplementation period, the subjects were given the cereal and nata de coco supplement twice daily before breakfast and dinner, otherwise, they were allowed to follow their own meal menus. The cereals and nata de coco supplement was formulated as shown in Table 1. The product was manufactured into powder form. For consumption, the subjects were instructed to add hot water to 15 g of the supplement (1 package) to get a final volume of 150 mL.

Statistical analysis

Conventional statistical methods were used for the calculation of mean ± standard error of mean (SEM). The independent samples t-test was used to determine significant changes of the means between groups (A and B), with a significance level of $p < 0.05$. The repeated measurement ANOVA was used to determine significant changes within groups (A and B) above the baseline, with a significance level of $p < 0.05$.
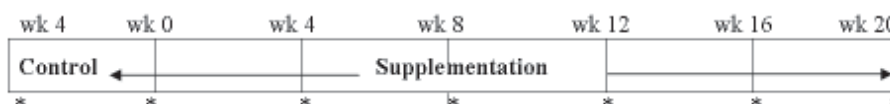
Figure 1. Experimental design.

Table 1. The ingredients of the cereals and nata de coco supplement

Ingredients	% (w/w)
Unpolished rice	6
Mung bean	18
Sweet corn	36
Nata de coco	40

Results and Discussion

The selected volunteers were hyperlipidemic patients from the Nutritional Clinic, Department of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand and Medical and Health Office, Electricity Generating Authority of Thailand (EGAT), Nonthaburi, Thailand. Among the 22 subjects, 11 were men and 11 were women, with age ranging from 32 to 75 years (mean ± SEM = 55.2±2.8 years), height of 160.4±2.0 cm, body weight of 68.2±2.8 kg and body mass index (BMI) of 26.6±1.0 kg/m^2. For initial characteristics of the volunteers, most of them (68.2%) were obese (BMI >24.9 kg/m^2). Most of them had normal blood pressure (BP) and all of them were non-smokers. Three subjects dropped out after week 12 of the study for personal problems.

After receiving the supplementation of cereals and nata de coco for 20 wk, the subjects were classified into two groups. Group A had a compliance record of $\geq$ 90% in taking the assigned supplement, and group B had a compliance record of < 90%. The mean (± SEM) cholesterol intakes of group A at weeks 0, 4, 8, 12, 16 and 20 were 305±14.8, 283.7±22.7, 285.1±22.9, 310.4±14.2, 282.6±23.1, and 285.5±12.8 mg/day, and in group B, 315±44.5, 313.5±16.6, 287.8±16.6, 327.0±17.9, 300.5±27.2, and 285.2±32.2 mg/day, respectively. These values were not significantly different from one another. Thus, their cholesterol intake should not be the major factor in altering their serum TC and LDL-C levels.

Tables 3 and 4 show means ± SEM of serum lipid levels in 22 hyperlipidemic subjects who were given the cereal and nata de coco supplement.

In Group A, significant differences were seen between the mean of TG level at wk 0 and the those at weeks 4, 8 and 16 (p<0.05), but no significant differences in TC, LDL-C and HDL-C

Table 2. Proximate, vitamin and mineral analysis of the cereals and nata de coco supplement (per 100g)

Composition	Concentration/100 g	Composition	Concentration/100 g
Moisture (% wet wt)	5.73	Potassium (mg)	757.00
Protein (% wet wt)	18.23	Iron (mg)	3.00
Fat (% wet wt)	1.55	Copper (mg)	0.40
Carbohydrate (% wet wt)	80.22	Zinc (mg)	2.30
Ash (% wet wt)	2.68	Chloride (mg)	44.00
Soluble dietary fiber (g)	0.70	Vitamin B$_1$ (mg)	0.16
Insoluble dietary fiber (g)	8.50	Vitamin B$_2$ (mg)	0.02
Vitamin A (µg)	Not detected	Vitamin B$_6$ (mg)	0.29
Vitamin C (mg)	Not detected	Vitamin B$_{12}$ (mg)	0.30
Vitamin E (mg)	0.50	Biotin (µg)	12.00
Calcium (mg)	40.00	Folic acid (µg)	176.00
Phosphorus (mg)	305.00	Niacin (mg)	1.10
Sodium (mg)	68.00	Pantothenic acid (mg)	0.60

Table 3. Means ± SEM of serum lipids in Group A on the cereals and nata de coco supplement.

mmol/L	week -4	week 0	week 4	week 8	week 12	week 16	week 20
TC	7.3±0.4	6.8±0.2	6.5±0.3	6.5±0.3	6.5±0.3	6.2±0.3[b4]	6.6±0.3
TG	2.7±0.1	2.6±0.1	2.0±0.2[b4]	2.0±0.1[b4]	2.2±0.2	2.1±0.3[b4]	2.1±0.3
LDL-C	4.8±0.4	4.3±0.2	4.2±0.3	4.2±0.3	4.2±0.3	3.9±0.2	4.3±0.3
HDL - C	1.3±0.1	1.3±0.1	1.3±0.1	1.4±0.1	1.3±0.1	1.4±0.1	1.3±0.1

Significant difference from week 0: [b4]$p < 0.05$, n = 15

Table 4. Means ± SEM of serum lipids in Group B on the cereals and nata de coco supplement.

mmol/L	week -4	week 0	week 4	week 8	week 12	week 16	week 20
TC	6.4±0.3	6.3±0.2	6.3±0.3	6.1±0.5	6.6±0.3	5.5±0.5	5.9±0.3
TG	2.6±0.1	2.3±0.1	2.7±0.4[C4]	1.9±0.2	2.7±0.3[C4]	2.3±0.3	2.2±0.2
LDL-C	4.2±0.3	4.2±0.2	4.0±0.2	4.1±0.4	4.4±0.4	3.5±0.4	3.8±0.3
HDL-C	1.0±0.1	1.1±0.1	1.1±0.1	1.1±0.1	1.0±0.1	1.0±0.1	1.1±0.1

Significant difference from group A at week 4: [C4]$p < 0.05$; at week 12: [C4]$p < 0.05$, n = 7

in all subjects, except TC level at wk 16 was significantly lower than that at wk 0 ($p<0.05$). No significant difference was seen in serum lipids in all subjects in Group B.

These findings confirm those of Mesomya *et al*. (2002), in which 4-week study was done on five kinds of dietary fiber diet on experimental rats. The results in that study indicated that rats fed with 40% nata de coco, 6% unpolished rice, 36% sweet corn and 18% mung bean (same supplement as in the current study) had a significantly lower serum TG level than those fed with the experimental diet of apple pectin and cellulose, even though the total dietary fiber in the supplement was lower than that in the two experimental diets, but no lowering effect on serum cholesterol.

According to Anderson *et al*. (1994), serum TG level is significantly ($p<0.05$) decreased (10%) in hypercholesterolemic men consuming wheat bran 40 g/day. The results of current study showed the serum TG lowering effect of the supplement, which was high in insoluble fiber. These results may indicate that it was the insoluble fiber in the supplement product that significantly reduced serum TG in hyperlipidemic subjects.

Conclusion

The purpose of this study was to investigate the effects of the cereal and nata de coco supplementation on the serum lipids of hyperlipidemic subjects. The 22 subjects used consisted of 11 men and 11 women with the average age of 55.2±2.8 years. They were instructed to consume diets that derived 15% of the calories from proteins, 30% from fats, and 55% from carbohydrates. Each subject was given 15 g of the supplement consisting of 40% nata de coco, 6% unpolished rice, 36% sweet corn and 18% mung bean, one before breakfast and another before dinner over 20 wk, with 4 wk control period prior to that. The 30 g supplement provided 122.6 kcal, 5.5 g protein, 0.5 g fat, 24.1 g carbohydrate and 2.7 g fiber. After 20 wk, the subjects who complied with the dietary assignment $\geq$ 90% of the time were classified as Group A, and those with < 90% as Group B.

Results showed no significant change in serum lipid levels during the control period. Only in Group A that significant differences were seen between the means of serum TG levels at week 0 and weeks 4, 8 and 16 ($p<0.05$). Serum TC level at

week 16 was also significantly lower than that at week 0 ($p<0.05$). Because the supplement was high in insoluble fiber, the results seem to imply that the insoluble fiber in the supplement was responsible for the reduction in serum TG of the hyperlipidemic subjects.

Acknowledgements

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