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The Hypocholesterolemic Effect of Phytosterol Ester-added Cheddar Cheese in Rats

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INTRODUCTION

The plasma cholesterol lowering properties of phytosterols has been known since the early 1950s, and there have been a plethora of studies reporting their hypocholesterolemic effects[1,2]. Increased cholesterol concentrations can be lowered by changing the fatty acid composition of diet, however, through consumption of products enriched with plant sterols[3].

Phytosterols or plant sterols are natural components of the human diet, which are structurally related to cholesterol[4]. In recent years, phytosterols have gained much attention as nutraceuticals for their blood cholesterol lowering efficacy[1,5]. This interest has now been translated into a range of health-promoting functional products, such as vegetable oil-based table spreads. Typically, the sterol content is between 6 and 10% to provide sufficient daily intake for the blood cholesterol lowering effect[5].

In the other side, most consumers are concerned about the excessive intake of cholesterol[6,7], since a strong positive correlation exists between increased serum cholesterol concentrations and risk of coronary heart disease. A number of studies have been indicated that the cholesterol removal in food, including milk, cream and cheese, was effectively conducted by β-cyclodextrin (β-CD)[8]. Therefore, this study was designed to carry out the development of phytoesterol ester-added Cheddar cheese with reduced cholesterol for lowering blood cholesterol.

MATERIALS AND METHODS

Animals and diets

Male Sprague-Dawley rats obtained from the Jung-Ang Lab. Animal, Inc. (Seoul, Korea) weighing 60 to 75g were placed individually in stainless-steel wire cages in a windowless room and were subjected to a light cycle with the light period from 1500 to 0300 and the dark period from 0300 to 1500. The rats were acclimatized for 1 week and fed a commercial rat chow during this period. All diets were formulated as recommended by the American Institute of Nutrition. All animals were fed a 40% beef tallow modified rodent diet with 5% cholesterol and 0.5% cholic acid for 5 week, and fat free purified diet containing

different cheesees for 6 week ad libitum. Animlas were given free access to tap water via a stainless steel delivery system.

By second week, the animals were fed high cholesterol- high fat diet for 6 weeks, and were assigned randomly to the following two groups: 1) control, fed a fat free diet containing 0.5 g /day of commercial cheese, and 2) phytosterol ester-added group (Phyto), fed a fat free diet containing 0.5 g /day of 8% phytosterol ester-added cholesterol-reduced cheese.

To examine blood analysis, animals were fasted for 12 hr and 1.5 mL blood sample was withdrawn from a tail and centrifuged at 3,000 rpm for 10 min, and stored at -20°C until analysis.

RESULTS AND DISCUSSION

After 5 weeks of 40% beef tallow and 5% cholesterol containing diet, the average food intake was 26 and 27 g/day during next 6 weeks. Body weight gain was not significantly different between control and phytosterol ester-added group as 66.5 and 67.9g for 6 week period (Table 1).

In blood analysis, after 5 weeks of high cholesterol, high fat diet feeding, the average total serum cholesterol was 153.4 and 161.9 mg/dL in control and phytosterol ester-added group, respectively (Table 2). During 6 weeks of experimental cheese feeding period, the serum cholesterol fed 8% phytosterol ester-added cheeses decreased significantly from 161.9 to 132.9 mg/dl. Comparatively, blood cholesterol in control slightly increased from 153.4 to 165.8 mg/dl, which was not significantly different. The serum high density lipoprotein (HDL) did not show any significant change during treatment. Serum triacylglycerol (TG) kept increasing from the initial to final week.

Since the hypocholesterolemic effect of phytosterol ester which has been reported in experimental animals and man for many years, we need to examine whether the 8% phytosterol ester-added cholesterol-reduced cheese is effective in lowering blood cholesterol in rat. Our present data indicated that 0.5g cholesterol-reduced cheese containing 8% phytosterol ester (400 mg/day) lowered the total blood cholesterol significantly, but almost did not influence on HDL cholesterol. Based on above results from this study, we suggest that phytosterol ester, which showed the hypocholesterolemic effect, could be added into cholesterolreduced Cheddar cheese without any profound adverse effect. Thus, this can be used to manufacture more effective dairy products in lowering blood cholesterol.

Table 1. Effects of experimental diets on food intake and body weight gain[1]

Treatment	Food intake (g/day)	Body weight gain (g/6 week)
Control[2]	26[a]	66.5[a]
Phyto[3]	27[a]	67.9[a]

[1] Rats were fed for 6 weeks. 1Means within column by the same capital letter are not significantly different ($P<0.05$).

[2] Cholesterol-reduced Cheddar cheese with no phytosterol ester addition 38% phytosterol ester-added cholesterol-reduced Cheddar cheese.

Table 2. Effects of experimental diets on the change of blood triacylglycerol, total cholesterol and high-density lipoprotein in rats fed 6 weeks1

Treatment	TG		Total CH		HDL	
	Initial	Final	Initial	Final	Initial	Final
			(mg/dL)			
Control[1]	64.5[a]	63.5[a]	153.4[a]	165.8[a]	32.3[a]	31.4[a]
Phyto[2]	58.9[a]	61.4[a]	161.9[a]	132.9[b]	39.5[a]	41.0[a]

[1]Cholesterol-reduced Cheddar cheese with no phytosterol ester addition.

[2]8% phytosterol ester-added cholesterol-reduced Cheddar cheese.

SUMMARY

This study was carried out to investigate the effect of phytosterol ester addition on lowering blood cholesterol in cholesterol-reduced Cheddar cheese, which was manufactured by the mixture of cholesterol-reduced cream and skim milk. After the cholesterol reduction process by β-CD treatment, the cholesterol removal rate was in the range of 91.2 to 92.1%. In animal study, 18% of total blood cholesterol was lowered in 8% phytosterol ester-added Cheddar cheese, which was significantly different from that of control. The present study indicated that phytosterol ester addition showed a profound lowering effect of blood with cholesterol-reduced Cheddar cheese.

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