Increase in Plasma HDL-Cholesterol Concentration in Goats Fed Sesame Meal Is Related to Ether Extract Fraction Included in the Meal

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ABSTRACT : Previously, we reported that a diet including sesame meal (SM) increased plasma total and high-density lipoprotein (HDL)-cholesterol concentrations in goats. In the present study, the components in the sesame meal that can increase plasma total and HDL-cholesterol concentrations have been examined. In experiment 1, we gave goats defatted sesame meal diet (DSM) to investigate the influence of ether extract fraction remained in sesame meal. Corn gluten meal diet (CGM) was also fed to goats as a high-protein diet to examine the influence of high dietary protein level caused by usage of sesame meal. Plasma total and HDL-cholesterol concentrations of goats fed DSM and CGM did not change during experimental periods though they were elevated by feeding SM. In experiment 2, the influence of sesame oil and corn oil added in diets on plasma total and HDL-cholesterol concentrations in goats was investigated. Plasma total and HDL-cholesterol concentrations were increased by feeding both corn oil diet and sesame oil diet. In conclusion, the increase in plasma HDL-cholesterol concentration by feeding sesame meal was resulted by the effect of ether extract fraction including sesame oil or some lipid-soluble components remained in sesame meal. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 4 : 511-514)***

Key Words : Sesame Meal, Sesame Oil, HDL-Cholesterol, Goats

INTRODUCTION

Sesame seed is known as one of healthy diets. There is a considerable studies examining the influence of dietary sesame seed and its ingredients on human health (Yamashita et al., 1992, 1995; Satchithanandam et al., 1993; Kang et al., 1998, 2000). In general, it was supposed that sesame lignans included in sesame seeds have the potency to decrease serum cholesterol level (Hirose et al., 1991; Hirata et al., 1996). However, in our previous study, when goats were fed sesame meal which is one of food-industrial by-products derived from sesame oil extraction process, plasma total and HDL-choleterol concentrations gradually and significantly increased (Hirano et al., 2002). Sesame meal used in the study included approximately 16% of ether extract and 43% of crude protein. It was also reported that plasma HDL-cholesterol concentration in ruminants was changed by varying dietary fat and protein levels (Park, 1985; Beynen et al., 2000). Therefore, to examine the influence of crude fat and protein remained in sesame meal on plasma HDL-cholesterol concentration in goats, we substituted sesame meal, defatted sesame meal and corn gluten meal for a part of concentrate given to goats, and measured the daily change in plasma HDL-cholesterol concentration. Additionally, we also examined the influence of dietary sesame oil supplemented in diets on plasma HDL-cholesterol concentration in goats.

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MATERIALS AND METHODS

Animals and diets

Two experiments were conducted to clarify the reason for the increase in plasma HDL-cholesterol concentration in goats fed sesame meal. In experiment 1, to investigate the influence of ether extract fraction remained in sesame meal, defatted sesame meal was given to goats. Corn gluten meal was also given to goats instead of sesame meal to examine the influence of high protein intake on plasma HDL-cholesterol level because the addition of sesame meal increases crude protein level in the diet. In experiment 2, the influence of dietary sesame oil added into diets containing timothy hay and concentrate was examined. In both experiments, six Japanese pygmy castrated male goats were used. These goats were 2 to 7 year old and castrated in 1 to 8 months old. The average body weight±SE was 37.1±2.6 kg in experiment 1 and 41.2±1.5 kg in experiment 2. In experiment 1 three experimental diets were prepared (Table 1). In the sesame meal diet (SM) group, animals were fed SM that was composed of 400 g/goat/day of timothy hay (Morinaga Milk Industry Co., LTD, Tokyo, Japan), 200 g/goat/day of concentrates “Kuroushi68” (Marubeni shiryo Co., LTD, Tokyo, Japan) and 200 g/goat/day of sesame meal (Takemoto Oil & Fat Co., LTD, Gamagori, Japan). In the defatted sesame meal diet (DSM) group, goats were fed DSM that was composed of 400 g/goat/day of timothy hay, 200 g/goat/day of concentrates and 175 g/goat/day of defattded sesame meal. Defatted sesame meal was prepared by extraction with diethyl ether to remove oil and lipid-soluble components

Table 1. Feeding levels and chemical compositions of experimental diets (experiments 1 and 2)

	Basal diet	Experiment 1			Experiment 2	
		SM[1)]	DSM[1)]	CGM[1)]	SO[1)]	CO[1)]
Feeding levels		g/goat/day				
Timothy hay[3)]	400	400	400	400	400	400
Concentrates[3)]	400	200	200	200	374	374
Sesame meal[3)]	-	200	-	-	-	-
Defatted sesame meal[3)]	-	-	175	-	-	-
Corn gluten meal[3)]	-	-	-	135	-	-
Sesame oil	-	-	-	-	26	-
Corn oil	-	-	-	-	-	26
Chemical compositions, g/kg diet						
Crude protein	93	161	158	178	88	88
Crude fat	20	52	18	18	52	52

[1)] Abbreviation used; SM, sesame meal diet; DSM, defatted sesame meal diet; CGM, corn gluten meal diet; CO, corn oil diet; SO, sesame oil diet.
[2)] Chemical analyses (crude protein and crude fat) of ingredients (g/kg): 34 and 13 in timothy hay; 151 and 27 in concentrates; 425 and 155 in sesame meal; 450 and 17 in defatted sesame meal; 630 and 20 in corn gluten meal; respectively.

from sesame meal. In the corn gluten meal diet (CGM) group, goats were fed CGM that was composed of 400 g/goat/day of timothy hay, 200 g/goat/day of concentrates and 135 g/goat/day of corn gluten meal. In experiment 2, two experimental diets were prepared (Table 1). In the sesame oil diet (SO) group, goats were fed SO that was composed of 400 g/goat/day of timothy hay, 374 g/goat/day of concentrates and 26 g/goat/day of sesame oil (Yamagatsura Sangyo Co., Ltd, Osaka, Japan). In the corn oil diet (CO) group, goats were fed CO that was composed of 400 g/goat/day of timothy hay, 374 g/goat/day of concentrates and 26 g/goat/day of corn oil (Yoneyama Yakuhin Kogyo Co., Ltd, Osaka, Japan).

Experiments

In experiment 1, six goats were housed in individual metabolism cages. Lighting was 14L10D. The basal diet (Table 1) was offered to all animals during preparatory periods (7 days). Then two goats each were allotted to one of three treatment groups. The SM, DSM and CGM were given for 12 days. These diets were divided equally and fed twice a day at 10:00 and 18:00 h. Goats were allowed free access to drinking water and trace-mineralized salt blocks (Cow candy ^{R}, Mercian Co., Ltd, Tokyo, Japan). Blood samples were taken every day at 09:50 and 14:00 h by jugular venipuncture. Plasma was separated and stored at -20°C until analyzed. Goats were assigned in a 3×3 Latin square design.

In experiment 2, six goats were kept as described in experiment 1. The basal diet was given to all animals during preparatory periods (7 days). Then the SO and CO were given for 12 days. The same experiment was repeated after goats were switched in treatments.

Analyses

Crude protein in the ingredients of experimental diets was determined by using Kjeldahl distilling unit "Kjeltec System 1026" (Tecator, Hoganas, Sweden). Crude fat was analyzed by Soxhlet's extractor "FATEX Speedy Fat Extractor Auto Program System" (Mitamura Riken Kogyo Inc., Tokyo, Japan).

Plasma concentrations of glucose, non-esterified fatty asid (NEFA), triglyceride, total cholesterol and HDL-cholesterol were measured by commercial kits (NEFA : NEFA C test Wako ; triglyceride : TG G test Wako ; total cholesterol : T-Cho E test Wako ; HDL-cholesterol : HDL-test Wako ; Wako Pure Chemical Co. Ltd., Osaka, Japan).

Statistical analyses

Data was analyzed by mixed two-factor within subject design (split-plot design). The main factor with independent groups was experimental diet (In experiment 1: SM vs. DSM vs. CGM; In experiment 2: SO vs. CO). The sub factor with repeated measures was experimental period (days). Data was calculated by a commercial statistical package SAS (SAS Institute Inc., Cary, NC, USA). For all analytical procedures, P-value of less than 0.05 was considered statistically significant.

RESULTS

Body weight change and food intake (experiments 1 and 2)

In both experiments 1 and 2, the body weight of goats in all dietary treatment groups was not changed significantly during experimental periods. Diets given to goats were not remained at the next feeding (data not shown).

Plasma lipid concentrations (experiment 1)

Plasma NEFA did not change by feeding experimental diets during experimental periods (data not shown). Plasma triglyceride concentrations in goats fed SM, DSM and CGM were 145±5 mg/L (mean±SE), 128±7 mg/L and 108±5 mg/L, respectively, and all data were significantly different each other. However, the main effect of experimental period and the interactive effect between experimental diet and experimental period were not significantly different. Plasma total cholesterol concentration of goats fed SM increased gradually during experimental period and it was significantly higher than those of other two groups after day 8 of experiment (Figure 1). The significant difference in plasma total cholesterol concentration between DSM and CGM groups was not observed. On plasma HDL-cholesterol concentration, the interaction between experimental diet and experimental period was significant (Figure 2). In goats

fed SM, plasma HDL-cholesterol increased with experimental days, and on the last day of experimental periods it was about 1.7 times as high as that on day 1. However, little change in plasma HDL-cholesterol concentration was observed in DSM and CGM groups during experimental periods.

Plasma lipid concentrations (experiment 2)

Types of oil did not affect plasma NEFA, triglyceride and total and HDL-cholesterol concentrations in goats. These plasma lipid concentrations increased with experimental days in both dietary groups as represented in Figures 3 and 4 (data of NEFA and triglyceride are not shown).

DISCUSSION

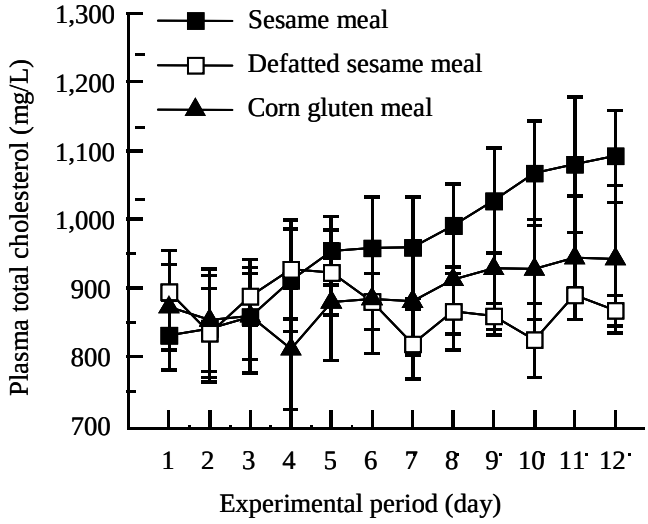

Figure 1. Influence of dietary sesame meal, defatted sesame meal and corn gluten meal on plasma total cholesterol concentration in goats. P-values of experimental diets, experimental periods and interaction between two factors were 0.001, 0.218 and 0.708, respectively. Values are means±SE; n=6.

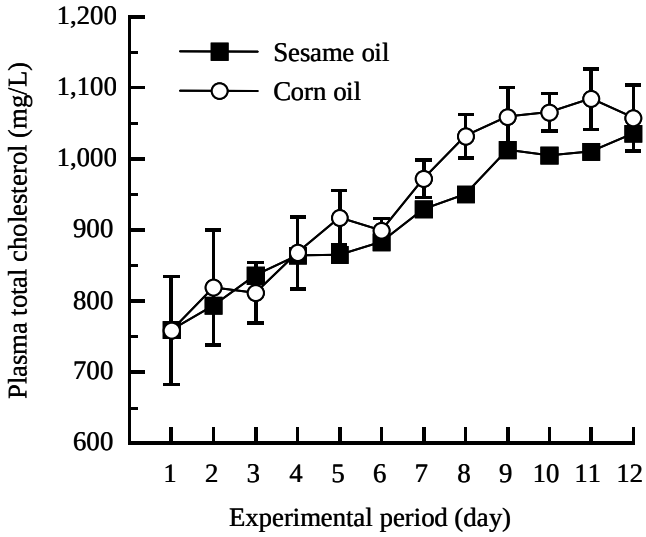

Figure 3. Influence of dietary sesame oil and corn oil on plasma total cholesterol concentration in goats. P-values of experimental diets, experimental periods and interaction between two factors were 0.123, <0.001 and 0.998, respectively. Values are means±SE; n=6.

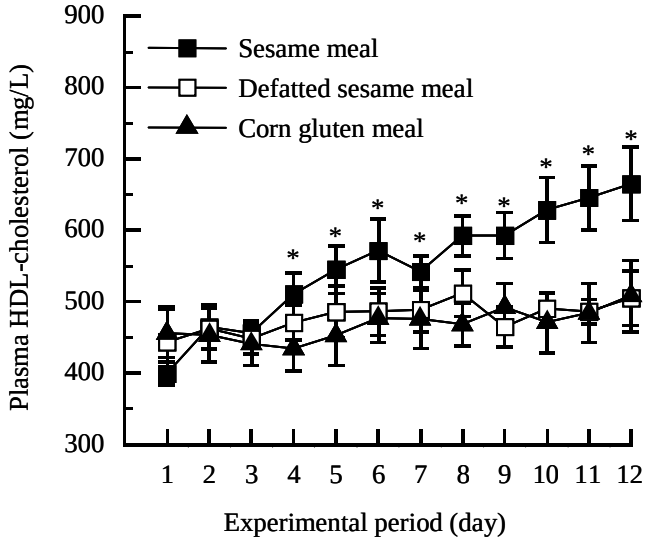

Figure 2. Influence of dietary sesame meal, defatted sesame meal and corn gluten meal on plasma HDL-cholesterol concentration in goats. P-values of experimental diets, experimental periods and interaction between two factors were <0.001, <0.001 and 0.049, respectively. * Significantly different compared to day 1 in each dietary treatment ($p<0.05$). Values are means±SE; n=6.

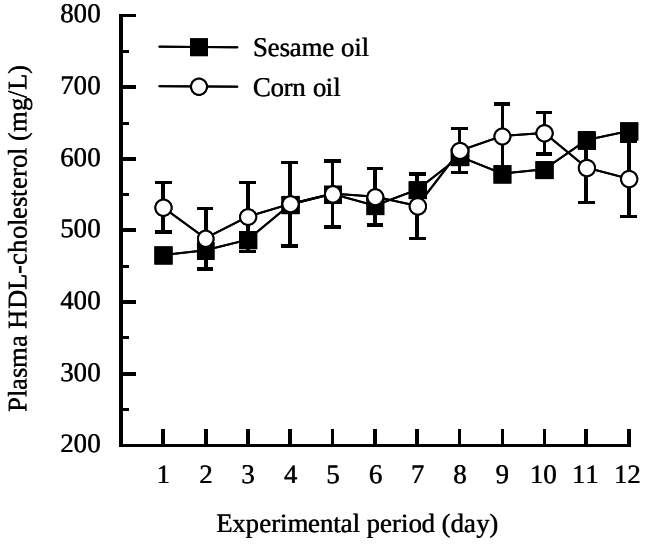

Figure 4. Influence of dietary sesame oil and corn oil on plasma HDL-cholesterol concentration in goats. P-values of experimental diets, experimental periods and interaction between two factors were 0.414, 0.038 and 0.998, respectively. Values are means±SE; n=6.

Body weight of each goat was not changed significantly in both experiments 1 and 2, which could be due to the feeding of experimental diets that were satisfied with nutritional requirements for goats (National Research Council, 1981).

In the present study, plasma triglyceride concentration was increased by substitution of sesame meal for concentrates. However, plasma triglyceride concentration in goats fed DSM was lower than that in the SM group. It might be due to the ether extract fraction remained in the sesame meal. Similar response in goats given diets added with various lipids was observed (Beynen et al., 2000).

In our previous study, we showed the remarkable increase in plasma total cholesterol concentration in goats fed a diet containing sesame meal (Hirano et al., 2002). In this experiment, the substitution of sesame meal for concentrate resulted in the increase in dietary crude protein content compared to the control diet. Therefore, CGM was given to goats to examine the influence of high protein intake on plasma total cholesterol concentration. However, as represented in Figure 1, CGM with high dietary protein content did not increase plasma total cholesterol concentration. This indicates that the increase in plasma total concentration of SM-fed goats was not associated with the high level of dietary protein content in SM.

Previously, we also reported that dietary sesame meal increased plasma HDL-cholesterol concentration in goats (Hirano et al., 2002). Sesame meal used in our previous study contained considerable amount of ether extract (16% of total weight). In experiment 1 in the present study, therefore, we removed ether extract fraction from the sesame meal and the influence of dietary defatted sesame meal on plasma total and HDL-cholesterol concentrations was examined. As shown in figures 1 and 2, plasma total and HDL-cholesterol concentrations in goats fed DSM did not change during experimental periods and they were significantly lower than those in goats fed SM. It was also reported that there was little effect of defatted sesame flour on plasma total and HDL-cholesterol concentrations in rabbits (Kang et al., 1999), which may suggest that regardless of animal species oil-free sesame meal has no effect on cholesterol metabolism.

As shown in Figures 3 and 4, when goats fed SO or CO, plasma total and HDL-cholesterol concentrations significantly increased with experimental periods. Beynen et al. (2000) reported that dietary olive oil and palm oil also increased plasma lipid levels in goats. However, the supplementation of sunflower oil, in which fatty acid components differed from those of sesame oil and corn oil, caused a significant increase of triglyceride level without an increase in HDL-cholesterol concentration in heifers (Park and Rafalowski, 1983). Therefore, further research should be required to make clear how various fatty acids regulate plasma HDL-cholesterol levels in ruminants.

In conclusion, the increase in plasma HDL-cholesterol concentration in goats fed sesame meal may be due to the remained ether extract fraction in sesame meal, and dietary sesame oil supplementation into diets causes an increase in plasma total and HDL-cholesterol concentrations in goats.

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