Food and Public Health 2012, 2(6): 193-196
DOI: 10.5923/j.fph.20120206.02

Effects of Sesame Seeds Consumption on Serum Cholesterol and Oxidative Status in Hypercholesterolemia

Sapwarobol Suwimol[1,*], Jiamjarasrangsi Wiroj[2], Wattanawiroon Kewalin[3], Jaritngam Natchapon[3], Hongsuwan Pathamaporn[3], Sathiensathidkun Auranun[3]

[1]Nutrition and Dietetics Program, Faculty of Allied Health Science, Chulalongkorn University, Bangkok, 10330, Thailand
[2]Department of Preventive and Social Medicine, Faculty of Medicine,Chulalongkorn University, Bangkok, 10330, Thailand
[3]Undergraduate Program in Nutrition and Dietetics, Faculty of Allied Health Sciences, Chulalongkorn University, Bangkok, 10330, Thailand

Abstract Sesame seeds and its lignans induce beneficial changes in risk factors related to cardiovascular disease in pre-clinical studies. This study aims to investigate the effects of sesame consumption on serum lipid profiles and oxidative status in hypercholesterolemic patients. After 2 weeks of run-in period, 18 (5 men and 13 women) subjects were assigned to consume 40 grams of roasted not crushed sesame seeds daily for 6 weeks. Anthropometric measurements, blood lipid profile and MDA were evaluated at before (baseline) and after intervention period. There were no significant differences on those anthropometric parameters at baseline and after the dietary intervention.Sesame seeds supplementation shows no significant effect in serum TC, LDL-C, TG, TG/HDL-C levels after 6 weeks of intervention. Concerning the serum antioxidant levels, no significant alteration in MDA concentrations were demonstrated at the end of the study. Ingestion of 40 g sesame seed daily posed no beneficial effects on serum lipids profile and oxidative status after 6 weeks of consumption. Higher doses of sesame seed consumption may be suggested for future study in order to obtain beneficial effects in lipid profiles. In addition, crushed sesame might be recommended to increase bioavailability of sesame lignans.

Keywords Sesame, Hypercholesterolemic, Oxidative-Status

1. Introduction

The association between dyslipidemia and cardiovascular disease (CVD) has been well established. The major risk factors for the development of cardiovascular disease are hypercholesterolemia, elevated LDL-cholesterol (LDL-C), and low HDL-cholesterol (HDL-C)[1]. In addition, free radicals mediated lipid peroxidation of polyunsaturated fatty acids of LDL-C and VLDL-C is a substantial event in the development of atherosclerotic lesions since theoxidized-LDL accumulated in the extracellularsub-endo-thelial space of arteries is highly atherogenic[2-3].Oxidized-LDL is also a cytotoxic to the vascular system[4].

Sesame (*Sesamumindicum Linn*.) has long been used as a traditional health food to prevent numerous diseases because of its active components. Sesame seeds are not only rich in oil and protein, but also in lignans (sesamin, sesamolin)[5]. Many nutraceuticals properties of sesame seeds have been established, including hypocholesterolemia, hypoglycemia, antioxidant and hepatoprotective effects as well as improve wound healing[6-10].

* Corresponding author:
suwimol.sa@chula.ac.th (SapwarobolSuwimol)
Published online at http://journal.sapub.org/fph

In animal studies, sesame seeds have been demonstrated to pose hypocholesterolemic effects in rats[11-12]. Administration of sesame seed powdertohypercholesterolemic albino rats resulted in a significant reduction in plasma, hepatic total lipid and cholesterol levels within 4 weeks of dietary intervention. These animals have increased fecal cholesterol excretion and bile acid production as well as increased in hapatic HMG-CoA reductaseactivity. Additionally, sesame seed feeding improved the hepatic antioxidant status by reducing lipid peroxidation[6].

In human studies, there were no significant alters in serum lipid profile and markers of oxidative status after 4 weeks of 25g/d sesame seed consumption in overweight and obese subjects[13]. Nevertheless, results from other studies shown significant decreased in serum total cholesterol (TC) and LDL-C[14].

Animal studies have established the beneficial effects of sesame seed consumption against CVD. A few intervention studies have investigated those effects inhypercholesterolemic subjects and the conclusion remains inconsistent. The objective of this study is to investigate the effect of consumption of 40g/d of sesame seeds on blood lipid profile and anti-oxidation status in hypercholesterolemic subjects.

2. Methods

Subjects

Twenty-eight hypercholesterolemic subjects, aged 18-50 years were recruited for the study through advertisements posted at Chulalongkorn University and a nearby community. All participants were in apparent good health as evaluated by medical history, physical examination and screening history interview by a registered dietitian. The eligibility criteria included (1) high serum cholesterol level (greater than 200 mg/dL) (2) not receiving medications or dietary supplements known to alter antioxidant levels; (3) no clinical history of cardiovascular, diabetes mellitus, hypertension or inflammatory diseases; (4) no alcohol intake; (5) no recent history of smoking. (6) no known dietary restrictions/food allergies. Twenty-eight volunteers were recruited to the study. Only 18 subjects completed the study. Five subjects reported anti-oxidant-related supplement used. Two subjects could not guarantee compliance to the study protocol and others three subjects dropped out because of personal reasons. These 18 subjects composed of 5 men and 13 women. The study protocol was approved by the Ethical Review Committee for Research Involving Human Research Participants, Health Science Group, Chulalongkorn University. Written informed consent was obtained from all study participants prior to enrolling to the study.

Study Design

This was a 6-weeks interventional study after 2 weeks of run-in period. The energy requirement of each subject was estimated on the basis of body weight, age, and physical activity. In this study, 18 subjects were assigned to consume 40 gram of roasted sesame seeds daily. A registered dietitian coached all subjects to ensure the caloric consumed. In order to evaluate and monitor the study's compliance, all subjects were requested to record the calories and sesame seedsconsumed at least 2 days a week, including 1 weekday and 1 weekend day throughout the study. Structured interviews were also utilized through at least 2 telephone calls per week. Subjects were requested to keep their lifestyles and exercise habit unchanged throughout the study. Roasted sesame seeds were given to subjects in a separate bag, each bag contains 40 g of roasted sesame seeds. Subject's number and date to consume were written on each bag. Return of empty bag requested in every clinic visit. Subjects were requested to visit the Nutrition and Dietetics clinic in every other week for anthropometric measurement including weight, BMI and body composition.

Anthropometrics Assessment

Weight, Body Mass Index (BMI), and percent body fat were measured at baseline (week-0) and the end of treatment period (week-6). Body weight, and percent body fat mass were assessed using a constant current source with a high frequency current (50kHz, 500μA)-bioelectrical impedance analyzer (BIA) (BC-418 body composition analyzer, TANITA corporation, Tokyo, JAPAN). The subject was requested to dress in light attire and bare feet. The 8 polar electrodes are positioned so that electric current is supplied from the electrodes on the tips of the toes of both feet and the fingertips of both hands, and voltage is measured on the heel of both feet and the thenar side of both hands. Body Mass Index (BMI) was calculated as weight/height^2 (in kilograms per square meter).

Blood Analysis

Fasting blood samples were also collected at baseline and the end of treatment period and were analyzed in a blind fashion. At the beginning (baseline) and at the end of the treatment period (week 6), 9 ml of overnight fasting venous blood samples was collected from all 18 subjects. Blood was collected in tubes that contained lithium heparin. Plasma was collected after centrifugation at 1500x g for 10 min at 4 degree C. Plasma MDA concentrations were analyzed by spectrophotometer, according to the method of Moore and Robert, 1998[15]. Plasma was mixed with 10% tri-chloroacetic acid (TCA), then centrifuged at 8000x g for 10 min. A 2-Thiobarbituric acid (TBA) was then added to the aliquots. The supernatant fluid was heated at 95 degree C for 10 min before measuring absorbance by spectrophotometer at 532 nm. Lipid profiles analysis was performed at baseline and after 6-weeks of the study. All of the anti-oxidation capacity and blood lipid profiles analysis have been done at Nutrition laboratory, Faculty of Allied Health Science, Chulalongkorn University.

Statistical Analysis

The characteristics of study subjects were described by frequency (gender) and mean and standard deviation or SD (age, body mass index, percent body fat mass, and baseline values of serum lipid and antioxidant profiles). The exception was for the TG/HDL-C ratio, where the median (25th and 75th percentiles) was presented due to its skew distribution.

In the examination of the intervention effectiveness, pre- and post-intervention differences of serum lipid and anti-oxidant profiles as well as the corresponding means and 95% confidence intervals or CIs were calculated. Paired t-test was also used to determine the significance of these differences with the p-value of less than 0.05 as the cut-off point for the statistical significance.

3. Results

Table 1. anthropometric measurements before and after the dietary sesame intervention

	baseline	After intervention	*p-value*
weight	58.26 ± 10.68)	56.68 ± 10.95	*0.066*
BMI (kg/m^2)	21.55 ± 2.33	21.71 ± 2.43	*0.066*
Fat mass (kg)	15.03 ± 4.68	15.26 ±4.56	*0.139*
Fat free mass (kg)	43.23 ± 10.16	43.42 ± 10.34	*0.317*

Table 2. Comparisons of the serum lipid profiles and oxidation status before and after the dietary sesame intervention

	Baseline Mean (95%CI)	After intervention Mean (95%CI)	Difference Mean (95%CI)	*p- value*
TC (mg/dl)	230.20 (217.33,243.07)	227.20 (208.35, 246.05)	-3.00 (-14.52,8.52)	*0.556*
LDL-C (mg/dl)	145.12 (134.76, 155.48)	145.17 (131.51, 158.82)	0.05 (-8.81, 8.91)	*0.990*
HDL-C (mg/dl)	68.85 (64.52, 73.18)	65.08 (60.51, 69.65)	-3.77 (-6.56, -0.98)	*0.012**
TG (mg/dl)	95.21 (68.35, 122.08)	77.64 (51.59, 103.34)	-17.57 (-30.47, -4.67)	*0.223*
TG/HDL-C ratio	1.27 (1.05, 1.65)τ	1.09 (0.84, 1.93)τ	0.06 (-0.28, 0.41)	0.557
LDL-C/HDL-C ratio	2.06 (1.94, 2.17)	2.48 (2.40, 2.57)	0.43 (0.30, 0.55)	0.000*
MDA (μmol/L)	1.54 (1.35, 1.73)	1.68 (1.44, 1.92)	0.14 (-0.06, 0.35)	*0.102*

All data expressed as mean (SD), Difference = after- beforeAll data expressed as mean (%95 CI) τdata expressed median(25th and 75th percentiles) due to skew distributionTC, total cholesterol; LDL-C, low- density lipoprotein; HDL, high-density lipoprotein; TG, triglyceridessignificant differences after sesame dietary intervention ($p < 0.05$)

The study subjects were 5 men and 13 women, with mean ± SD of age 31.78 ± 10.11 years of age. Their mean ±SD of BMI, fat mass and fat free mass were 21.55 ± 2.33 kilogram/m2, 15.03 ± 4.68 kg and 43.23 ± 10.16 kg respectively. There were no significant differences on these anthropometric parameters at baseline (before) and after the dietary intervention (Table 1). There were also no significant changes in usual diet and physical activities over the study period.

Table 2 shows no significant effect of sesame seed supplementation in serum TC, LDL-C, TG, TG/HDL-C observed after 6 weeks of intervention. However, comparisons of serum fasting lipid profiles showed that only serum HDL-C levels were significantly reduced after the sesame intervention, with the means (95% CIs) of -3.77(-6.56, -0.98) mg/dl, p=0.0124 (Table 2). Concerning the serum antioxidant levels, no significant alteration in MDA concentrations were demonstrated at the end of the study (week 6) (Table 2).

4. Discussions

The results from this study showed that consumption of 40 g/d of roasted sesame seeds for 6 weeks did not pose any benefit on markers of CVD risk in hypercholesterolemic patients as it did not improve any serum lipid profiles including TC, LDL-C, HDL-C, TG and oxidative status.

There are a numbers of published human studies that have reported the potential hypocholesterolemic effect of sesame consumption. Study showed that ingestion of 40 g/d of sesame seeds for 60 days caused significant decreases in plasma TC and LDL-C.[16]. Hirata et al. (1996) also reported that daily ingestion of 32 g sesame seeds for 4 weeks decreased LDL-C concentrations by 16 % in hypercholesterolemicpatients[17]. However, these studies were limited to a very small sample size. In addition, supplementation of 50 g/d of sesame seeds for 5 weeks showed an approximate 10% reduction in LDL-C in post-menopausal Asian women[18]. In contrast a well randomized, cross-over study reported that 25g/d sesame supplementation for 5 weeks did not affect LDL-C or any other lipid parameters in 33 overweight and obese men and women[13]. In this study, diet was well matched between the sesame and placebo to minimize the effect of confounding factors.

In accordance to our finding, we observed no health benefit of 40 g/d sesame supplementation on TC, LDL-C, HDL-C and TG. In our study, dietary intake was kept unchanged throughout the study to prevent the effects of macronutrients composition on serum lipid profiles. Our results were then least confounded. The difference in our results to Wu et al 2006 may reflect differences in population and higher amount of sesame (50 g/d)[18]. In our study, the amount 40 g/d of sesame was chosen according to subject's acceptable level. Further, this amount is beyond the high end of normal intake in Asian populations[19]. Finally, the difference in our investigation to Wu et al 2006[18] could have been due to the use of whole and not crushed sesame seeds, causing to reduce bioavailability of sesame lignans.

In this study, sesame consumption posed no significant changes in TC, TG, LDL-C and TG/HDL-C ratio parameters. The reason to support this observation remains unclear. One of purpose mechanism is that the high saturated fatty acids content of sesame seeds could influences serum lipid profiles[20]. Another reason can be due to the fact that TG and HDL-C levels in our subjects were in the normal range at baseline; it was assumed that there would be no reducing effect of 40 g/d sesame consumption on serum TG and HDL-C levels.

It has been reported that sesamolin, a sesame seed lignin, may reduce lipid peroxidation in rats[21]. Inhypercholesterolemic patients, 4 weeks sesame seed consumption has significantly increased antioxidant capacity by prolonging LDL oxidation time and decreasing MDA generation in LDL-C[14].

Despite previous reports of anti-oxidative status in animal studies, we investigate no change in oxidative status follow-ing 40 g/d of sesame consumption. Study in overweight men and women also demonstrated that 25 g/d sesame supplementation did not change any systematic markers of inflammation[13]. There may be species differences in sesame lignin bioavailability which account for this difference. In addition, it could have been due to the use of not crushed sesame seeds, causing to reduce bioavailability of sesame lignans. Accordingly, antioxidant properties following sesame consumpion was most pronounced in rats. Inanimal study, sesame supplementation can increase antioxidant capacity only when serumconcen- tration of sesame lignans and their metabolites levels were greater than 1 μM. However, a recent study reported that serum sesamin and their metabolites reached 100 nM following an at least 50 g of sesame seed ingestion[22].

5. Conclusions

In this study, consumption of 40 g/d sesame seeds posed no beneficial effects on serum lipids profile and oxidative status after 6 weeks. Higher doses of sesame seed supplementation may be suggested for future study to determine beneficial effects. In addition, crushed sesame might be needed to increase bioavailability of sesame lignans.

ACKNOWLEDGEMENTS

This work was supported by staffs at Nutrition laboratory, Faculty of Allied Health Science, Chulalongkorn University. We are grateful for a very helpful of all participants in this project.

REFERENCES

[1] S.M. Grundy, Small LDL, artherogenic dyslipidemia, and the metabolic syndrome. Circulation 95, 1-4, 1997.

[2] G. Spiteller, The relation of lipid peroxidation processes with artherogenesis: A new theory on atherogenesis. Molecular Nutrition and Food Research 49, 999-1013, 2005.

[3] S. Steinberg, Low density lipoprotein oxidation and its pathological significance. Journal of Biological Chemistry 272, 20963-20966, 1997.

[4] D.W. Morel, J.R. Hessler, G.M.Chisolm, Low density lipoprotein cytotoxicity induced by free radical peroxidation of lipid. Journal of LipidRresearch 24, 1070-1076, 1983.

[5] M. Beroza, M.L.Kinman, Sesamin, sesamolin and sesamol content of the oil of sesame seed as affected by strain, location growth, aging and frost damage. Journal of the American Oil Chemist's Soceity 32, 348-50, 1955.

[6] N.P. Visavadiya, A.V.R.L. Narasimhacharya, Sesame as a hypocholesteraemic and antioxidant dietary component. FdChem Toxicology 46, 1889-1895, 2008.

[7] B.S. Wang, L.W.Chang, W.J. Yen, P.D. Duh, Antioxidative effect of sesame coat on LDL oxidation and oxidative stress in macrophages. Food Chemistry 102, 351-360, 2007.

[8] K.C. Jeng, R.C.Hou, J.C.Wang, L.I.Ping, Sesamin inhibits lipopolysaccharide-induced cytokine production by suppression of p38 mitogem-activated protein kinase and nuclear factor-κB. Immunology Letters 97, 101-106, 2005.

[9] D. Sanjar, A. Ali, G. Sambandam, R. Rao, Sesame oil exhibits synergistic effect with anti-diabetic medication in patients with type 2 diabetes mellitus. Clinical Nutrition 30, 351-358, 2011.

[10] R.R. Shenoy, A. T. Sudheendra, P.G. Nayak, P. Paul, N.G. Kutty, M. Rao, Normal and delayed wound healing is improved by sesamol, an active constituent of *Sesamumindicum* (L.) in albino rats. Journal ofEthnopharmacology 133, 608-612, 2011.

[11] S.Sirato-Yasumoto, M. Katsuta, Y. Okuyama, Y. Takahashi, T. Ide, Effects of sesame seeds rich in sesamin and sesamolin on fatty acid oxidation in rat liver. Journal of Agricultural and Food Chemistry 49, 2647-51, 2001.

[12] L. Ashakumary, I .Rouyer, Y .Takahashi, T. Ide, N. Fukuda, T. Aoyama, Sesamin, a sesame lignin, is a potent inducer of hepatic fatty acid oxidation in the rat. Metabolism 48, 1303-13, 1999.

[13] J.Wu, J .Hodgson, I .Puddey, R. Belsji, V. Burke, K. Croft, Sesame supplementation does not improve cardiovascular disease risk markers in overweight men and women. Nutrition Metabolism and Cardiovascular Disease 19, 774-780, 2009.

[14] P. Chen, K. Chien, T. Su, C. Chang, T. Liu, H. Chang, Dietary sesame reduces serum cholesterol and enhances antioxidant capacity in hypercholesterolemia. Nutrition Research 25, 559-567, 2005.

[15] K.Moore, L.J.Roberts, Measurement of lipid peroxidation. Free Radical Research 2,659-671,1998.

[16] B. Alipoor, M.K. Haghighian, B.E. Sadat, M. Asghari, Effect of sesame seed on lipid profile and redox status in hyperlipidemic patients.International Journal of FoodScience and Nutrition 1-5, 2012.

[17] F. Hirata, K. Fujita, Y. Ishikura, K. Hosoda, T.Ishikawa, H. Nakamura, Hypocholesterolemic effect of sesame lignan in humans. Atherosclerosis 122, 135-6, 1996.

[18] W.H. Wu, Y.O. Kang, N.H. Wang, H.J. Jou, T.A .Wang, Sesame ingestion affects sex hormones, antioxidant status and blood lipids in postmenopausal women. Journal of Nutrition 136, 1270-5, 2006.

[19] M. Namiki, Nutraceutical functions of sesame: a review. Critical Review in Food Science and Nutrition 47, 651-73, 2007.

[20] D.L. Nelson, M.M. Cox, Lehningerpronciplesof biochemistry 3rd edition, New York: Worth Publishers 2000

[21] M.H. Kang, M. Naito, N. Tsujihara, T.Osawa, Sesamolin inhibits lipid peroxidation in rat liver and kidney. Journal of Nutrition 128, 1018-1022, 1998.

[22] M. Kushiro, Y. Takahashi, T.Ide, Species differences in the physiological activity of dietary lignan (sesamin and episesamin) in affecting hepatic fatty acid metabolism. British Journal of Nutrition 91, 377-86, 2004.