The effects of low-calorie diet with canola oil on blood lipids in hyperlipidemic patients

MOSTAFA NOROOZI – ROZA ZAVOSHY – HASSAN JAHANI HASHEMI

Summary

Hyperlipidemia is known as a risk factor for cardiovascular disease. The purpose of this study was to investigate the effect of canola oil with low-calorie diet on blood lipids in hyperlipidemic patients. The study was carried out on sixty hyperlipidemic patients of both sexes and age range of 25–65 years. The patients received low-calorie diet based on 5857 KJ energy per day for 4 weeks, containing 29% fats, 17% proteins and 54% carbohydrates. In addition to the low-calorie diet, the intervention group received canola oil (30 $g \cdot d^{-1}$). Weight, body mass index, waist and hip circumferences were significantly reduced ($P < 0.05$) after 4 weeks in both groups. Treatment with canola oil was associated with a significant reduction ($P < 0.05$) in serum triacylglycerols.

Keywords

canola oil; low-calorie diet; hyperlipidemia; serum lipids

Atherosclerosis is called a silent disease because many individuals are asymptomatic until the occurence of first myocardial infarction, which is often fatal [1]. Hyperlipidemia and serum lipid abnormalities are established as major risk factors for this disease [2].

Canola oil is rich in monounsaturated fatty acids (MUFA) [3] and polyunsaturated fatty acids (PUFA) [4, 5]. This type of oil is a source of the dietary precursor for the long-chain omega-3 PUFA eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA) [6]. In an intervention study with canola, maize and olive oils in hyperlipidemic subjects, a reduction in plasma total cholesterol (TC) was seen. However, the reduction was significantly greater for the canola and olive oil groups, but there was no significant effect on plasma triacylglycerols (TAG) [7]. Three weeks' diet supplemented with sunflower oil or canola oil in two groups of hyperlipidemic patients, showed a stronger reduction in the serum TAG concentration for the sunflower oil group [8]. A 3.5 weeks' diet supplemented with canola oil or olive oil with twenty-two hyperlipidemic patients showed a similar reduction in the total serum cholesterol and LDL in both groups [9]. In a recent study in moderately hyperlipidemic subjects, consumption of palm oil and partially hydrogenated soya oil elevated the concentration of LDL cholesterol, in comparison with canola oil [10].

The effects of canola oil with a low-calorie diet on blood lipids in hyperlipidemic patients have not been studied thoroughly. Hence, the objective of this study was to investigate the effect of canola oil with low-calorie diet on blood lipids, TAG, TC, LDL and high-density lipoprotein (HDL) in hyperlipidemic patients. Since there are side effects in long-term medications in hyperlipidemic patients, healthy diet may be a choice for the improvent of their blood lipid profile.

MATERIAL AND METHODS

Participants

This randomized clinical trial was conducted on 62 hyperlipidemic patients who were healthy in other respects and were recruited from nutrition and diet therapy clinic in Qazvin. For the personal reasons, two subjects of the control group dropped out before the end of the study. The in-

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clusion criteria required the age of 25–65 years. They had at least one of blood lipid indices including TC ≥ 5.18 mmol·l^{-1}, HDL ≤ 1.04 mmol·l^{-1}, LDL ≥ 2.59 mmol·l^{-1} and TAG ≥ 1.70 mmol·l^{-1}. Exclusion criteria included pregnancy and lactation, smoking, steroid therapy, taking lipid-lowering drugs, hormones and a personal history of nephropathy, cardiovascular disease, diabetes or other chronic disease.

Protocol

Sixty subjects (52 female and 8 male) participated in this study. They were randomly divided into treatment (n = 30), and control (n = 30) groups. All subjects received a low-calorie diet based on 5 857 KJ energy per day for 4 weeks, containing 29% fats, 17% proteins and 54% carbohydrates from a registered dietitian. Although the treatment group received more energy intake, in comparison with the control group, the difference of energy intake between the two groups was insignificant (P = 0.14).

Thirty patients (treatment group) received canola oil (30 g·d^{-1}) in addition to the low-calorie diet. The canola oil was produced by Frico (Faravardehaye Roghany Iran, Canola Oil Company, Tehran, Iran) and had a national quality control certificate number 4935, and contained: 62.4% MUFA, C18:1, 28.8% PUFA, C18: 2 & 3 and 8.8% saturated fatty acids (SFA, C14–C22). The low-calorie diet with canola oil was well tolerated and accepted. Oral and written instructions for recording foods were given to all subjects by the clinical nutritionist.

Seven-day food records and main daily nutrient intake record was completed by subjects during the last week of the study. These records were reviewed by the clinical nutritionist for checking the diet compliance. Subjects' compliance was assessed by analysing the records using a computerized nutrient database (Dorosty Food Processor – DFP, version 2003, Shahid Beheshti University, Tehran, Iran), which is mainly based on the national nutrient composition data. Blood samples were obtained after an overnight (12 h) fasting period before the study and on the last day of the intervention period. Anthropometric indices and levels of serum TAG, TC, LDL and HDL were measured before and after the intervention. Serum total cholesterol and triacylglycerol concentration were measured by commercially available enzymatic reagents (Pars Azmoon, Tehran, Iran) adapted to Selectra autoanalyzer (Vital Scientific, Spankeren, Netherlands). HDL-cholesterol was measured after precipitation of the apolipoprotein B containing lipoproteins with phosphotungistic acids [11]. Inter- and intra-assay coefficients of variation were both less than 5% for all these measurements.

Measurements

Body weight was measured while the subjects were minimally clothed, without shoes. Digital scales were used and recorded to the nearest 0.1 kg. Height was measured in a standing position, without shoes, using a tape meter while the shoulders were in a normal state. Waist circumference was measured to the nearest 0.1 cm at the narrowest level over light clothing, using an unstretched tape measure, without any pressure to body surface. During the study, participants were asked not to change their habitual physical activity levels. All participants provided informed written consent. The protocol was approved by the Research Council and Ethical Committee of Qazvin University of Medical Sciences.

Statistical Analyses

Results are presented as mean ± standard deviation. Statistical analysis was performed by descriptive statistics and using paired t-test, for change in each group, independent t-test for baseline comparison in two groups, one sample t-test for decreasing of blood lipids (α = 0.05). The reduction percent of blood lipids after intervention was calculated as

$$\% \text{ reduction (loss)} = 100 \times \frac{(X_1 - X_2)}{X_1} \qquad (1)$$

where X_1 is blood lipids before intervention; and X_2 is blood lipids after intervention.

RESULTS AND DISCUSSION

The mean age of subjects was 39.7 years ± 10.0 years and the average of body mass index (BMI) and waist-to-hip ratio (WHR) were (33.6 ± 5.1) kg·m^{-2} and (0.96 ± 0.06), respectively (Tab. 1). There were no significant differences in age, weight, height, waist, hip, BMI, WHR, TC, TAG, LDL, HDL, LDL/HDL and Chol/HDL between the two groups (treatment and control) at the baseline (Tab. 2). Weight, BMI, waist, hip circumferences and WHR were significantly reduced (P < 0.05) after 4 weeks in both groups (Tab. 3). Percent change from the baseline in weight, waist, hip, BMI and WHR were not significant in two groups. There were no significant differences at the beginning of dietary intervention (baseline) between plasma lipid concentrations.

Tab. 1. Characteristics of hyperlipidemic patients.

	Mean ± SD
Age [year]	39.7 ± 10.0
Weight [kg]	87.1 ± 14.4
Height [cm]	160.9 ± 7.1
Waist [cm]	109.7 ± 13.6
Hip [cm]	113.9 ± 10.9
Body mass index [kg·m^{-2}]	33.6 ± 5.1
Waist to hip ratio	0.96 ± 0.06
Blood lipids:	
Total cholesterol [mmol·l^{-1}]	6.02 ± 0.86
Triacylglycerides [mmol·l^{-1}]	2.44 ± 1.48
Low-density lipoproteins [mmol·l^{-1}]	3.63 ± 0.81
High-density lipoproteins [mmol·l^{-1}]	1.20 ± 0.31
LDL/HDL	3.1 ± 1.1

Number of patients $n = 60$.
LDL – low-density lipoproteins, HDL - high-density lipoproteins, SD – standard deviation.

A low-calorie diet with canola oil intervention resulted in significantly lower levels of TAG than the baseline (2.29 mmol·l^{-1} ± 1.05 mmol·l^{-1} versus 1.73 mmol·l^{-1} ± 0.88 mmol·l^{-1}, $P < 0.05$). Canola oil with low-calorie diet was associated with a significant reduction in serum TAG ($P < 0.05$). Intervention diet with canola oil significantly decreased TC compared with the baseline (5.86 mg·dl^{-1} ± ± 0.88 mg·dl^{-1} versus 5.47 mg·dl^{-1} ± 0.99 mg·dl^{-1}, $P < 0.05$), but compared with the control group, this change was insignificant. No significant change occurred in LDL, HDL and LDL/HDL (Tab. 3).

Karavonen et al. [12] reported that after consumption of 65 g·d^{-1} of canola oil-based cheese in hypercholesterolemic subjects for 6 weeks, serum total and LDL cholesterol were decreased, but reduction in HDL cholesterol was seen, too. In another study with a high-unsaturated-fat diet at a 8 786.4 KJ energy level, after 19 weeks consumption of intervention diet with canola oil, total and LDL cholesterol were reduced [13].

Our results are not consistent with observations of Karvonen et al. [12] and Swain et al. [13], which at a higher amount of canola oil and longer study period resulted in a reduction of TC and LDL cholesterol. The present study showed a significant reduction in triacylglycerol after consumption of 30 g·d^{-1} canola oil with a low-calorie diet. Our results are in concordance with those of Rodríguez-Cruz et al. [14] and Nielsen et al. [15], who reported that diet with canola oil reduced the serum triacylglycerol concentration.

Hypertriglyceridemia is known as a risk factor for atherosclerotic coronary heart disease and metabolic syndrome. One therapeutic option to lower TAG levels is consumption of omega-3 fatty acids [14]. Canola oil is a good source of plant ALA dietary precursor (α-linolenic acid) for the long chain omega-3 PUFA eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) [16, 17]. Omega-3 fatty acids reduce the synthesis and secretion of very-low-density lipoprotein (VLDL) particles and increase TAG removal from VLDL and chylomicron particles through the up-regula-

Tab. 2. Characteristics of 60 hyperlipidemic patients at baseline.

	Treatment group	Control group	*P* value
Age [year]	40.9 ± 7.5	38.2 ± 7.9	0.88
Weight [kg]	88.5 ± 13.9	85.7 ± 14.9	0.47
Height [cm]	161.5 ± 5.8	160.3 ± 8.1	0.50
Waist [cm]	110.3 ± 15.1	109.1 ± 12.2	0.73
Hip [cm]	115.5 ± 10.7	112.3 ± 11.1	0.25
Body mass index [kg·m^{-2}]	33.9 ± 5.2	33.3 ± 5.2	0.68
Waist to hip ratio	0.95 ± 0.06	0.97 ± 0.05	0.21
Blood lipids:			
Total cholesterol [mmol·l^{-1}]	5.86 ± 0.88	6.18 ± 0.83	0.14
Triacylglycerides [mmol·l^{-1}]	2.29 ± 1.05	2.22 ± 1.21	0.45
Low-density lipoproteins [mmol·l^{-1}]	3.50 ± 0.84	3.68 ± 0.73	0.22
High-density lipoproteins [mmol·l^{-1}]	1.20 ± 0.34	1.19 ± 0.27	0.88
LDL/HDL	3.2 ± 1.3	3.2 ± 0.8	0.81

Values are means ± standard deviation. LDL – low-density lipoproteins, HDL - high-density lipoproteins.

Tab. 3. Cardiovascular risk factors of 60 hyperlipidemic subjects before and after dietary intervention, in two groups.

	Low calorie diet with canola oil (n = 30)		Low calorie diet without canola oil (n = 30)	
	Before	After	Before	After
Blood lipids:				
Total cholesterol [mmol·l^{-1}]	5.86 ± 0.88	5.47 ± 0.99 *	6.18 ± 0.83	5.53 ± 1.12 *
Triacylglycerides [mmol·l^{-1}]	2.29 ± 1.05	1.73 ± 0.88 *	2.22 ± 1.21	1.93 ± 1.39
LDL [mmol·l^{-1}]	3.50 ± 0.84	3.40 ± 0.92	3.68 ± 0.73	3.37 ± 0.76
HDL [mmol·l^{-1}]	1.20 ± 0.34	1.16 ± 0.32	1.19 ± 0.27	1.14 ± 0.18
LDL/HDL	3.2 ± 1.3	3.1 ± 1.2	3.2 ± 0.8	3.1 ± 0.7
Weight [kg]	88.5 ± 13.9	85.1 ± 14.3 *	85.7 ± 14.9	81.3 ± 14.8 *
Waist [cm]	110.3 ± 15.1	106.9 ± 14.4 *	109.1 ± 12.2	81.3 ± 14.8 *
Hip [cm]	115.6 ± 10.7	113.0 ± 10.5 *	112.3 ± 11.1	108.9 ± 10.7 *
Body mass index [kg·m^{-2}]	33.9 ± 5.3	32.6 ± 5.3 *	33.3 ± 5.2	31.7 ± 5.2 *
Waist to hip ratio	0.95 ± 0.06	0.94 ± 0.07 *	0.97 ± 0.05	0.96 ± 0.62 *

Values are means ± standard deviation. LDL – low-density lipoproteins, HDL - high-density lipoproteins. * – $P < 0.05$.

tion of certain enzymes, such as lipoprotein lipase [18]. In the present study, no significant change occurred in HDL. This result is consistent with previous reports [10, 15, 19, 20].

In some intervention studies, three days' food record was used [20] to reach a more accurate estimation of energy and macronutrients intake, the subjects of this study were asked to record their foods for one week.

According to the results, we can state that canola oil with low-calorie diet, as a part of healthy diet, lowered the serum TAG level. This effect is beneficial and may reduce the cardiovascular risk factor in hyperlepidemic patients.

Acknowledgements

The authors would like to thank the Deputy of Research, Qazvin University of Medical and Health Sciences, Qazvin, Iran, for financial help (Grant No. 28.20.1379). The authors also thanks to Mr. Mirsalim, (Chemical Engineer and manager of Frico Canola Oil Company, Tehran, Iran) for financial support. We would also like to thank Dr. Saeed Assefzadeh, Department of Social Medicine for consultation, and Mrs. Mohtaram Adineh, Laboratory of Human Nutrition, Qazvin University of Medical Sciences for analysing the data on the diet composition.

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Received 26 October 2009; revised 4 December 2009; accepted 9 December 2009.