

Effects of oral vitamin C supplement on the serum lipid profile

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ABSTRACT

Purpose: Ascorbic acid has protective effects against coronary heart disease. These effects are attributed to its antioxidant properties and its relation to plasma lipids. This study investigated the effects of supplementing one gram of vitamin C per day on the serum lipoproteins of healthy 18 to 55 years old individuals in Iran.

Materials and Methods: This study was conducted on 55 healthy individuals aged 18 to 55 years old at a medical center of Iran's Army. None of the participants had taken vitamin supplements three months before participating in the study. Their diet patterns were evaluated by estimating the energy and nutrients intake. At the beginning of the study, serum triglyceride, high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C) and total cholesterol levels of the participants were measured. Then, the participants received one gram of vitamin C on a daily basis for 30 days. Blood parameters were measured on the 15th and 30th days of supplementation and were compared with each other. The findings were analyzed with Student's *t*-test and analysis of variance (ANOVA) test using Statistical Package for Social Sciences (SPSS) software version 18.

Results: After receiving vitamin C supplement for 30 days, a significant reduction was seen in the participants' total cholesterol level (12.2%) and average plasma triglyceride concentration level (8.09%). HDL cholesterol level significantly increased (14.5%) after one month of vitamin C supplementation ($P = .032$).

Conclusion: Taking one gram of vitamin C daily may significantly reduce serum lipoprotein levels in healthy individuals.

Keywords: vitamin C; lipid profile; lipoprotein; cardiovascular diseases; antioxidant properties.

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INTRODUCTION

Atherosclerosis disease is a problem of today's societies. Heart attacks and ischemia are the major clinical symptoms of atherosclerosis. Cardiovascular diseases are responsible for 39% of all fatalities in Iran.¹ Various studies show that in patients with coronary heart diseases, the major risk factor is high blood cholesterol in 18%, hypertension in 20%, and smoking in 22%.^{2,3}

This suggests that atherosclerosis develops after progressive thickening and hardening of the walls of medium and large arteries as a result of fat deposits on their inner lining. In fact, the primary damage is to

the blood vessels' endothelial cells that in turn initiate a series of reactions that will lead to coronary events. Hyperlipidemia, i.e. deposition of lipid on the initial layer, is a risk factor of this disease.^{4,5} Various studies show that increased serum triglyceride, total cholesterol, low density lipoprotein cholesterol (LDL-C) and decreased high density lipoprotein cholesterol (HDL-C) levels could increase the risk of this disease.^{6,7} Up to now, drug therapy has been the only option of treatment for patients with hyperlipidemia.

Based on epidemiological studies, vitamin C can be effective in increasing serum HDL-C and decreasing

serum LDL-C, total cholesterol and triglyceride levels. In addition, as an antioxidant, vitamin C can protect the blood vessels' walls against free radicals.^{7,8} This study has investigated the effects of taking one gram of vitamin C supplementation per day on the serum lipoproteins of healthy 18 to 55 years old individuals in Iran.

MATERIALS AND METHODS

This interventional and analytic research was conducted to evaluate the effects of edible vitamin C supplement on plasma lipid parameters (including LDL, HDL, total cholesterol, and triglyceride) of healthy individuals before and after supplementation. To this end, a protocol for using biochemical methods, plasma lipid parameters and food intake was defined for two days before beginning of supplementation.

The participants were Iran's Army personnel who participated in taking supplements and blood samples. Any volunteer from among these personnel who could meet the criteria of the study was accepted to participate in the research. The criteria for selecting the sample volume was based on previous studies on parameters of the largest scale deviation by taking the average into account (total cholesterol) using the $N =$ equation with 95% reliability. Thus, 55 individuals were chosen as participants. However, due to some problems such as phobia from blood sampling, the number of participant was reduced to 45 people.

For each person, a questionnaire was filled about personal descriptions, including age, height, weight, education, supplementation stage and special medications, etc. Then another questionnaire gathered information on ingredients of consumed food, amount and personal consumption. The participants completed the forms in two days in three stages (before, during and after supplementation). In the beginning, each food item consumed by each person after being cooked was calculated manually in grams. Then, using food parameter II (FPII) software, the amount of energy, protein, carbohydrates, total fat, saturated fatty acids, unsaturated fatty acids with one or multi-dual links, cholesterol, total vitamin A, dietary fiber, percentage of fat calories, and consumed vitamins E and C by the person were extracted.

The statistical methods used in this research included: (1) Descriptive statistical methods for providing personal, economic, and social descriptions and anthropometric indicators and biochemical parameters; (2) Student's *t*-test for comparing the quantitative variants during different periods of supplementation and (3) Analysis of variance (ANOVA) for comparing possible differences

in some subgroups.

Finally, [Q] and [bar] charts were used for presenting the results and statistical package for Social Sciences (SPSS) version 18, Epi Info6, and Microsoft Excel 2007 were used for data analyses.

RESULTS

The average age of the volunteers in this study was 31.96 ± 8.96 years old (age range of 18 to 55 years old). Considering that all the volunteers were in one age range, no significant correlation was found between age and blood lipid profile.

Among the participants, 85% were naturally healthy based on their employee profiles. In this study, there was not significant difference between the participants' average body mass index (BMI) during the different supplementation periods. However, because of cigarette's effect on expelling vitamin C through urination and its effect on blood lipoproteins, this factor could have been a confounding factor in this study. In order to nullify the role of this factor, all participants were chosen from non-smokers.

In addition, since taking vitamin supplements containing vitamins A, E, and C changes the blood lipid profiles, participants were chosen from those who had taken their last vitamin supplement at least three months before their participation in the study. Also, they were advised to take no supplementations other than vitamin C during the study.

Average energy, carbohydrate, total fat, protein, cholesterol, and fiber intake were measured. Hence, the amount of energy intake of the participants did not change significantly during the different periods of supplementation. Since fats are among the energy sources in foods, and there were no changes in dietary patterns regarding total fats, this can explain the fixed energy intake by the participants.

Furthermore, there were no significant changes in the amount of protein intake during the different periods of supplementation. Because of the importance of meat, dairy and cereal products as protein sources, their consumption patterns were remained fixed during the different periods of supplementation.

There were no significant changes in animal protein intake between the different periods of supplementation. In this sense, 49.7%, 52.5%, and 51.6% of the protein intake in the beginning, middle and end of study were provided from animal sources. The diet contained a desirable quality of animal protein for all participants during the different periods of supplementation since

in a suitable diet one third of the protein must come from animal sources. In this study, the animal protein consumption remained unchanged during the different periods of supplementation. Cholesterol intake also had no significant changes. So these two had no effect on lipid profile. In this study, there were no significant changes in food consumption on the whole during the different periods of supplementation.

Vitamin C supplementation's effect on total cholesterol

Averages of total cholesterol deviation in the 15th and 30th day of supplementation were 187.1 ± 14.66 and 171.9 ± 20.07 mg/dl. Thus, there was a significant difference between the total cholesterol levels during the different periods of supplementation. ($P = .032$)

Vitamin C supplementation's effect on triglyceride

Diet, estrogen, alcohol, obesity, etc. were among the factors that affected the level of plasma triglyceride. In this study, the agents that could interfere with the level of triglyceride were kept approximately fixed. Also, evaluation of the diet of individuals who had used 24-hour diet reminder shows that there were no significant changes in the food intake during the study. Prescription of vitamin C supplement caused a significant change in individuals' plasma triglyceride. The plasma triglyceride averages and standard deviations before the beginning of supplementation and on the 15th and 30th days of supplementation were $19/25 \pm 164/2$, $21/30 \pm 157/3$ and $20/41 \pm 151/9$ mg/dl mg/dl, respectively. Also, there were significant changes in terms of plasma triglyceride during different periods of supplementation. ($P = .038$)

Vitamin C supplementation's effect on HDL cholesterol

Consuming vitamin C caused a significant increase in individuals' HDL cholesterol. The average and the standard deviation of the plasma HDL cholesterol before the beginning of supplementation and on the 15th and 30th days of supplementation were $50/61 \pm 3/00$, $47/33 \pm 3/03$ and $44/8 \pm 2/85$ mg/dl, respectively. So, there was a significant change in HDL cholesterol during the different periods of supplementation. ($P = .04$)

Vitamin C supplementation's effect on LDL cholesterol

Consuming vitamin C supplement caused a significant increase in individuals' LDL cholesterol. The averages and

standard deviations of plasma LDL cholesterol before the beginning of supplementation and on the 15th and 30th days of supplementation were 19.25 ± 95.71 , 19.27 ± 100.65 , and 19.27 ± 111.3 mg/dl, respectively. Also, there was a significant change in terms of LDL cholesterol during the different periods of supplementation. ($P = .036$)

Vitamin C supplementation's effect on HDL, LDL, triglyceride/HDL-C

In addition to examining the effects of vitamin C supplement on total cholesterol, triglyceride, LDL and HDL cholesterol, in this study the triglyceride/HDL-C and LDL/HDL ratios were assessed. The results showed a reduction in these ratios because of vitamin C consumption. The averages and standard deviations of the triglyceride/HDL-C ratio before the beginning of supplementation and on the 15th and 30th days of supplementation were 3.24 ± 0.68 , 3.63 ± 0.70 and 3.4 ± 0.69 mg/dl, respectively. Also, there was a meaningful change in terms of triglyceride/HDL-C ratio during the different periods of supplementation. ($P = .034$)

Based on the average and standard deviation, the LDL/HDL cholesterol ratios before the beginning of supplementation and on the 15th and 30th days of supplementation were 1.8 ± 0.56 , 1.2 ± 0.55 and 2.5 ± 0.62 mg/dl, respectively. So there was a significant change in terms of LDL/HDL cholesterol during the different periods of supplementation. ($P = .037$)

DISCUSSION

In the present study a significant reduction was seen in the participants' total cholesterol level (12.2%) and average plasma triglyceride concentration level (8.09%) after one month of vitamin C supplementation. HDL cholesterol level significantly increased (14.5%) after one month of vitamin C supplementation. Also, a significant decrease in participants' LDL cholesterol concentration level (14%) and LDL-C/HDL-C ratio (28%) was seen after one month of supplementation with vitamin C. Evaluation of the changes in the average energy intake and other nutritional items during the different periods of supplementation with vitamin C revealed that the diet patterns of the participants during one month of supplementation with vitamin C had no significant changes.

There are differences in the results of the studies of other researchers on blood lipid parameters after intake of vitamin C supplements.^{5,7} One of the reasons for these differences could be lack of control in distorting agents

in the previous studies.⁹

The effect of type and amount of fat and also cholesterol in food on total plasma cholesterol has been shown in numerous studies.^{10,11} It has been proven that saturated fat and cholesterol have increasing effect and unsaturated fats have decreasing effect on the total cholesterol count. In clinical studies, many researchers have observed that reduced consumption of fat, saturated fat and cholesterol, associated with increased intake of unsaturated fats can lead to 10-15% increase in plasma total cholesterol, leading to a significant decrease in the atherosclerosis progress in coronary vessels.^{12,13} Calories from saturated fat are the most important indicators in defining the level of plasma cholesterol of individuals. Studying of patients with metabolic disease has shown that for each percentage of change in calories from saturated fat, the plasma cholesterol decreases by 4%.¹⁴

Therefore, in order to decrease the blood atherogenic lipids, it is suggested to consume unsaturated poly fats. The amount of ascorbic acid must also be taken into consideration. This confirms the ineffectiveness of unsaturated poly fats in the cardiovascular diseases and atherosclerosis symptoms. On the other hand, clinical studies have shown that vitamin C levels have been lower in these individuals.^{15,16}

Several studies have been conducted to examine the effects of antioxidant vitamins on lipid profile.² Among the most important antioxidant vitamins, vitamins A and E (dissolved in fat) and vitamin C (dissolved in water) are notable.^{17,18} Various studies have shown that increase in dietary antioxidants such as vitamins E, C and B carotene are in direct connection with reduced risk of cardiovascular diseases.¹⁹ In a study, low HDL-C was a stronger risk factor compared to high LDL-C cholesterol. Results from epidemiological research show that when plasma HDL cholesterol is below 35mg/dL, the chances of heart diseases caused by coronary vessels increases.²⁰

CONCLUSION

Consuming one gram of vitamin C for 30 days may significantly change the concentration of plasma lipid and lipoproteins in healthy individuals. Of course, the risks of possible kidney stone formation in people who are susceptible to kidney stones should not be ignored. In those individuals, such a high dosages of supplementation may prepare the grounds for formation of kidney stones. Since these individuals are constantly at risk, we hope that the results of this study can address some of the existing discrepancies in this regard and lead to preventing or controlling the effects of the above-mentioned diseases.

CONFLICT OF INTERESTS

None declared.

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