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Effect of Sumac (*Rhus coriaria*) Extract on Blood Lipid Profile in White Wistar Rats

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ABSTRACT

Background: Hyperlipidemia is a chronic disease whose current treatments are proper diet and chemical drugs. The evaluation of accessible medicinal plants has an important role in the prevention and treatment of hyperlipidemia. In this study, we investigated the effect of sumac (*Rhus coriaria*) extract on blood lipid profile in white Wistar rats. **Methods:** This laboratory animal experiment was conducted over 4 weeks on 21 white Wistar rats. The rats were divided into three groups and were fed by normal diet, fatty diet without sumac extract, and fatty diet with sumac extract. Rats were excluded if they exhibited sick-like behaviors. Data were analyzed in SPSS v. 16 software using analysis of variance and least significant difference tests. **Results:** The mean weight of the rats was 310±26 g. From the second week to the end of the study, the mean blood cholesterol was significantly different in the rats that received a fatty diet with sumac compared to the rats in the control group (P=0.001). Also during the study, mean triglyceride levels were significantly higher in the rats that received a fatty diet with sumac compared to the rats in the control group (P=0.047). During the study, too, mean high-density lipoprotein and low-density lipoprotein levels showed no significant change (P=0.641). **Conclusion:** We found that, in a small sample of white Wistar rats, sumac with a fatty diet effectively reduced blood cholesterol and may possibly assist in the prevention and treatment of hyperlipidemia.

INTRODUCTION

Increased levels of plasma lipids, especially total cholesterol, triglycerides, and low-density lipoprotein (LDL) associated with high-density lipoprotein (HDL) levels are the known causes of hyperlipidemia, which is a significant risk factor for atherosclerosis (1,2). Atherosclerosis is recognized as one of the primary causes of mortality worldwide (3,4). Most studies in this field have shown that hypercholesterolemia is associated with atherosclerosis more than other plasma lipids (5). According to the World Health Organization, in 2005, approximately 11 million people worldwide died annually from cardiovascular disease, which accounted for 30% of all deaths. In Iran, 38% of deaths are from cardiovascular disease, which is the primary cause of mortality annually (3). Several reports have suggested that hypercholesterolemia is more common in the incidence of atherosclerosis than other plasma lipids (5). Therefore, the prevention of hyperlipidemia has always been an important health concern, especially in populations at high risk for vascular diseases and atherosclerosis.

Over the years, new medical technologies, extensive studies on the effectiveness of medications and their possible side effects, and searches for new medicinal resources, especially plant sources, have increased. *Rhus coriaria* is a herb with anti-hyperlipidemic properties. According to various reports, *R. coriaria* has antibacterial and antioxidant properties due to significant amounts of water-soluble tannin compounds, and it can be effective at preventing the onset of cancer (6-8). In our study, we evaluated the effects of *R. coriaria* extract on plasma lipid profiles.

METHODS

In this laboratory animal experiment, *R. coriaria* extract was first prepared and then administered with a fatty diet to only one group of rats. The study population included three groups of seven adult male Wistar rats weighing 200-250 g. The rats were divided into three groups and separately fed

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with a normal diet (first group), a fatty diet with sumac extract (second group), and a fatty diet without sumac extract (third group). The rats of all three groups were quarantined for 1 week, and then they were tested for 2 weeks. For testing purposes, blood sampling (from the corner of the eye) was performed after 15 hours of fasting in order to measure lipid factors. (The high-fat diet used for second and third groups consisted of pellets containing olive oil and cholesterol powder.) To determine if the rats exhibited any sick-like behaviors, they were followed up for 1 week after blood sampling. Overall, the total duration of the program was 4 weeks.

Required observational information was recorded during the study in special checklists. After completing the sampling, the items in the checklists were analyzed. The checklists contained comprehensive tables for recording changes in lipid profiles of the rats at the specified times (baseline, end of the second week, and end of the fourth week). Finally, the data were analyzed with SPSS v. 16 software using the analysis of variance (ANOVA) test and t-tests. The statistical population included 21 adult male Wistar rats weighing 200-250 g, which were divided into three groups of seven and tested in parallel ways. After sampling, performing specific experiments, and recording the lipid profiles of rats in all three groups, the results were recorded in a special table.

RESULTS

Total cholesterol changes were evaluated in the three groups according to the desired time in pairs and using the least significant difference (LSD) test from the total post-hoc tests related to the ANOVA test (Table 1). No significant differences were observed in the control group during the three trial periods. However, in the group that received a fatty diet without sumac extract, total cholesterol increased steadily; these significant changes were observed during all three periods. Moreover, with respect to the group that received a fatty diet with sumac extract, total cholesterol levels did not differ significantly from baseline to the end of the second week. In this group, total cholesterol levels decreased from the second week to the end of the study. Again in this group, the difference in total cholesterol levels at the end of the fourth week was significant at baseline and at the end of the second week (P=0.001).

As presented in Table 2, changes in triglyceride levels were also assessed in the three groups according to the desired time. Values in the control group did not show any significant differences. However, in the group that received a fatty diet without sumac extract, triglyceride levels steadily increased during the study period (P=0.001). For each of the three tests performed for the three periods, this group showed a significant difference in triglyceride levels. Conversely, the mean changes in the group that received a fatty diet without sumac extract were not significant between baseline and the end of the second week. However, mean triglyceride levels after the second week increased significantly from 235.71±18.06 to 267.85±21.88 mg/dL (P=0.002).

As presented in Table 3, no significant differences were observed in changes in HDL levels in the control group, which is similar to the results presented in previous tables. Also, no significant differences were observed in the second group between the second and fourth weeks. Furthermore, the difference was not significant in this group between baseline and the second week, as well as between baseline and the end of the fourth week. For the third group, differences were not significant in any of the periods. Regarding the power of the LSD test as reported in Table 3, no significant changes were observed in any of the groups over the three periods considered.

No differences were observed in LDL levels in the control group (Table 4). Significant increases were observed in the second group from baseline to the end of the study: the mean LDL level increased from 87.71±15.41 mg/dL at baseline to 102.00±11.87 mg/dL at the end of second week and to 131.57±15.57 mg/dL at the end of the fourth week (P=0.001). The difference in mean LDL level in the second group after the end of the study was significant. In the third group, the mean LDL level increased significantly from 86.85±16.81 to 111.57±11.10 mg/dL at the end of the second week (P=0.029).

Table 1. Comparison of mean total cholesterol levels in different groups according to different periods

Total cholesterol	Time of evaluation	Mean±SD (mg/dl)	P
Normal diet (control)	Baseline	149.14±5.72	Between baseline and the end of the second week, 0.535
	End of second week	154.42±18.50	Between the end of the second week and the end of the fourth week, 0.224
	End of fourth week	146.28±8.90	Between baseline and the end of the fourth week, 0.484
Group with fatty diet	Baseline	153.57±10.40	Between baseline and the end of the second week, 0.004
	End of second week	204.85±27.74	Between the end of the second week and the end of the fourth week, 0.019
	End of fourth week	248.28±14.03	Between baseline and the end of the fourth week, 0.001
Group with fatty diet and sumac extract	Baseline	150.57±8.05	Between baseline and the end of the second week, 0.733
	End of second week	152.85±14.05	Between the end of the second week and the end of the fourth week, 0.001
	End of fourth week	121.39±9.73	Between baseline and the end of the fourth week, 0.001

Table 2. Comparison of mean triglyceride levels in different groups according to different periods

Triglyceride	Time of evaluation	Mean±SD (mg/dl)	P
Normal diet (control)	Baseline	214.14±11.59	Between baseline and the end of the second week, 0.244
	End of second week	224.71±30.37	Between the end of the second week and the end of the fourth week, 0.727
	End of fourth week	219.00±15.89	Between baseline and the end of the fourth week, 0.641
Group with fatty diet	Baseline	221.57±10.45	Between baseline and the end of the second week, 0.001
	End of second week	257.28±11.75	Between the end of the second week and the end of the fourth week, =0.001
	End of fourth week	309.28±12.60	Between baseline and the end of the fourth week, 0.001
Group with fatty diet and sumac extract	Baseline	223.85±16.81	Between baseline and the end of the second week, 0.329
	End of second week	235.71±18.06	Between the end of the second week and the end of the fourth week, 0.053
	End of fourth week	267.85±21.88	Between baseline and the end of the fourth week, 0.002

Table 3. Comparison of mean HDL levels in different groups according to different periods

HDL (High-density lipoprotein)	Time of evaluation	Mean±SD (mg/dl)	P
Normal diet (control)	Baseline	25.71±3.90	Between baseline and the end of the second week, 0.374
	End of second week	28.00±3.21	Between the end of the second week and the end of the fourth week, 0.0.94
	End of fourth week	26.85±3.18	Between baseline and the end of the fourth week, 0.558
Group with fatty diet	Baseline	26.71±4.07	Between baseline and the end of the second week, 0.493
	End of second week	27.28±3.81	Between the end of the second week and the end of the fourth week, 0.49
	End of fourth week	27.85±4.22	Between baseline and the end of the fourth week, 0.726
Group with fatty diet and sumac extract	Baseline	29.42±2.57	Between baseline and the end of the second week, 0.0.71
	End of second week	26.85±2.34	Between the end of the second week and the end of the fourth week, 0.084
	End of fourth week	25.00±9.48	Between baseline and the end of the fourth week, 0.257

Table 4. Comparison of mean LDL levels in different groups according to different periods

LDL (Low-density lipoprotein)	Time of evaluation	Mean±SD (mg/dl)	P
Normal diet (control)	Baseline	75.71±13.46	Between baseline and the end of the second week, 0.442
	End of second week	80.71±4.75	Between the end of the second week and the end of the fourth week, 0.712
	End of fourth week	81.71±6.57	Between baseline and the end of the fourth week, 0.37
Group with fatty diet	Baseline	87.71±15.41	Between baseline and the end of the second week, 0.072
	End of second week	102.00±11.87	Between the end of the second week and the end of the fourth week, 0.001
	End of fourth week	131.57±15.57	Between baseline and the end of the fourth week, 0.001
Group with fatty diet and sumac extract	Baseline	86.85±16.81	Between baseline and the end of the second week, 0.029
	End of second week	111.57±11.10	Between the end of the second week and the end of the fourth week, 0.315
	End of fourth week	90.00±52.70	Between baseline and the end of the fourth week, 0.902

DISCUSSION

We found that total cholesterol and triglycerides increased significantly in rats that received a fatty diet without sumac extract, although HDL levels were unchanged in this group during the 4-week study period. In the main experimental group that was fed a fatty diet with sumac extract, total cholesterol levels showed no difference during the first 2 weeks, but significant decreases in total cholesterol

values were observed from day 14 to day 28. However, throughout the entire period, triglyceride levels did not significantly increase. Since triglyceride changes similar to those reported in the experimental group were uniformly increased in the control group, we conclude that sumac extract did not have much effect on changes in triglyceride levels, or, in other words, in preventing their increase. However, sumac was effective at preventing a rise in total cholesterol levels over the first 2 weeks and was effective at decreasing cholesterol levels during the next 2 weeks compared to baseline.

Cholesterol plays a greater role in the development of atherosclerosis and vascular diseases than other plasma lipids; therefore, it is of particular importance if cholesterol levels can be controlled with sumac consumption. This potential therapeutic effect appears to be due to the presence of methanolic component of aqueous extract of sumac, which is a competitive inhibitor of oxidase and superoxide free radicals (9). Other studies have considered the antioxidant effects of sumac (10). More precisely, by evaluating the constituent elements of this plant, the plant's anti-cholesterol capabilities can be attributed to potential physiological mechanisms. In high-performance liquid chromatography analysis for aqueous extract of sumac, four phenolic acids have been identified: the most important is gallic acid, followed by vanillic acid, protochatechuic acid, and P-OH-benxoic acid (7). Mavlyanov et al. observed the presence of anthocyanin compounds in sumac. Most importantly, tannin compounds are present in this plant, including hydrolysable gallotannins (11-15), whose primary structural unit is poly(d-glucose carbonate). In general, the presence of antioxidant elements in the structure of sumac and their half maximal inhibitory concentration index is very important in this plant (16-19). To a large extent, it is because of this that antioxidant expectations are justified from experiments on this plant.

According to our findings, sumac (*R. coriaria*) extract is effective at preventing the collapse of plasma lipid balance. It can also help in some cases to reduce plasma lipids to normal levels. According to findings from previous studies, this capability appears to be due to the antioxidant properties of phenolic compounds and, most importantly, to tannin compounds that are present in this plant.

In line with our findings, to reduce the risk of developing metabolic and vascular diseases we recommend the inclusion of sumac in fatty diets, especially for people at risk for systemic and metabolic diseases. Despite the findings of this study and those of similar studies, much is still unknown with respect to the structure of *R. coriaria*, the mechanism of its effects in different doses, the effectiveness of various species, and complications that may result from its use. Thus, additional studies are needed.

CONCLUSION

We found that, in a small sample of white Wistar rats, sumac with a fatty diet effectively reduced blood cholesterol and may possibly assist in the prevention and treatment of hyperlipidemia.

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AUTHORS CONTRIBUTION

All authors equally contributes in this study.

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