Significance of Garlic and Its Constituents in Cancer and Cardiovascular Disease

Including Garlic in the Diet May Help Lower Blood Glucose, Cholesterol, and Triglycerides[1–3]

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ABSTRACT Raw and boiled aqueous extracts of garlic (*Allium sativum*) were administered daily to normal rats both orally and intraperitoneally for 4 wk. The serum levels of glucose, cholesterol, and triglycerides were measured. When the rats were treated with a low dose (50 mg/kg) of raw aqueous extract of garlic, no significant changes in the serum glucose levels were observed compared with the control group. However, there was a significant reduction in the cholesterol level of rats receiving a low dose of garlic (11–14%). Rats receiving garlic orally and intraperitoneally also showed a significant reduction in triglyceride levels (38%). When the rats were treated with a high dose (500 mg/kg) of raw garlic, glucose, cholesterol, and triglyceride levels were significantly affected. When boiled garlic extracts were administered at high concentrations (500 mg/kg), there was no effect on the level of serum glucose. However, a relatively small but significant decrease in the concentration of cholesterol and triglycerides was observed in the serum of the rats receiving boiled garlic. Raw garlic had a profound effect in reducing the glucose, cholesterol, and triglyceride levels, whereas boiled garlic had little effect in controlling these parameters. Therefore because hyperlipidemia is a major etiopathological factor for atherosclerosis, garlic may play an important role in the prevention of atherosclerosis. J. Nutr. 136: 800S–802S, 2006.

KEY WORDS: • *cholesterol* • *garlic* • *glucose* • *triglycerides*

Hyperlipidemia is a major risk factor involved in ischemic heart disease. During the last few decades, the hypolipidemic effect of garlic and onion has been confirmed by many investigators (1–5). There are many drugs in the market that control hypercholesterolemia and hypertriglyceridemia. Garlic and onion are said to lower serum cholesterol, enhance fibrinolytic activity, and inhibit platelet aggregation and thromboxane formation (6–11). There have also been reports on the beneficial effects of garlic extract and oil (12–14) in controlling hyperlipidemia in animals. Adding garlic to sucrose and cholesterol in the diet of rats prevents an increase in serum and liver cholesterol, triglycerides, and free fatty acids (15,16). Moreover, the addition of garlic decreases blood sugar with a concomitant increase in liver glycogen. These effects were attributed to the presence of sulfur compounds in the garlic (17).

High doses of garlic (1 g/kg) have been reported to have beneficial effects in reducing hyperlipidemia (18). The aim of this investigation was to study the efficacy of an aqueous extract of raw garlic in controlling levels of sugar, cholesterol, and triglycerides in the blood of normal rats treated orally and intraperitoneally daily for 4 wk. Because there have been many inconsistent reports about the use of different preparations of garlic, we decided to use the aqueous extract of garlic.

MATERIALS AND METHODS

Female Sprague-Dawley rats weighing 200–250 g and maintained on a normal diet and tap water ad libitum were used throughout the experiment. The rats were divided into 5 groups as follows: Group 1 received normal saline and served as a control; group 2 rats were orally force-fed garlic by stomach gavage using ball-tipped needle; group 3 received garlic by intraperitoneal injection; group 4 rats were orally

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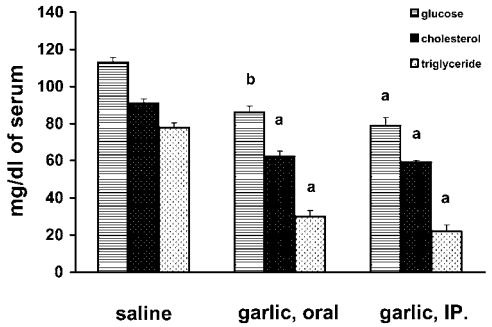

FIGURE 1 Effect of raw garlic (500 mg/dL) on glucose, cholesterol, and triglyceride levels in rat serum. Saline treated, $n = 14$; oral garlic, $n = 8$; intraperitoneal garlic, $n = 8$. a, statistically significant difference from the control group by Student's t test, $P < 0.001$; b, Statistically significant difference from the control group by Student's t test, $P < 0.01$.

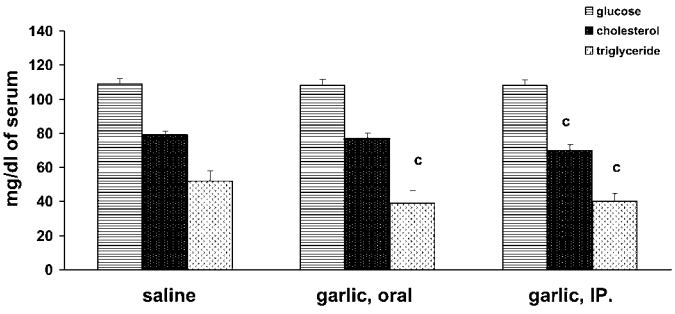

FIGURE 3 Effect of boiled garlic (500mg/kg) on glucose, cholesterol, and triglyceride levels in rat serum. Saline treated, $n = 8$; oral garlic, $n = 7$; intraperitoneal garlic, $n = 7$. c, statistically significant difference from the control group by Student's t test, $P < 0.05$.

force-fed boiled garlic using the same method as in group 2; and group 5 rats were given intraperitoneal injections of boiled garlic.

The animals were given 0.5 mL aqueous extract of garlic every d for 4 wk. After the 4-wk treatment, the rats were killed using urethane anesthesia. The blood was collected by cardiac puncture and allowed to clot, and the clotted blood was then centrifuged at 3500 × g for 30 min. The serum was separated and stored at −80°C for cholesterol and triglyceride analysis. Serum glucose was determined immediately by the glucose oxidase method using kits supplied by Randox. Cholesterol and triglyceride levels in the serum were measured using enzymatic kits also supplied by Randox.

Aqueous extract of raw garlic was prepared as described previously (19). Boiled extract of the bulbs was obtained by heating the raw extract for 10 min in a boiling water bath. Both extracts were stored in aliquots at −20°C and thawed daily for administering to animals. The experimental data are expressed as means ± SEM and were analyzed by two-tailed Student's t test. A level of $P < 0.05$ was considered to be significant.

RESULTS AND DISCUSSION

This study produced consistent results when an aqueous extract of raw garlic was given to rats either orally or intraperitoneally. When aqueous extracts of garlic were used at a high concentration (500 mg/kg), there was a significant decrease in the serum-glucose concentration (**Fig. 1**). However, no significant change in the level of glucose was observed in the serum of rats receiving low doses (50 mg/kg) of garlic (**Fig. 2**). No reports have been published on the hypoglycemic effects of garlic in normal human or animal studies. High doses of boiled garlic extract had no hypoglycemic effect on the serum glucose level in rats (**Fig. 3**). These results suggest that boiling garlic destroys the active, volatile, and chemically unstable ingredient(s) in this herb that may be responsible for lowering the blood sugar level. Thus, garlic will be more beneficial in lowering blood glucose when taken in the raw form rather than in the cooked form.

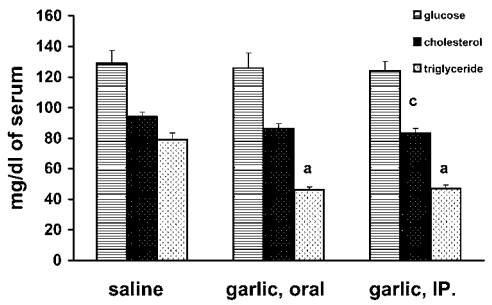

FIGURE 2 Effect of raw garlic (50 mg/dL) on glucose, cholesterol, and triglyceride levels in rat serum. Saline treated, $n = 10$; oral garlic, $n = 8$; intraperitoneal garlic, $n = 8$. a, statistically significant difference from the control group by Student's t test, $P < 0.001$; c, statistically significant difference from the control group by Student's t test, $P < 0.05$.

It was previously reported that administering an aqueous extract of garlic for 2 mo decreased cholesterol levels (28%) in 5 hypercholesterolemic patients (20). Several reports fail to confirm this effect of *Allium* species on blood lipids (21,22). This inconsistency may be due to the use of different preparations and various modes of administering these herbs. In contrast, the results in the present study, using a fresh aqueous garlic extract, were more consistent.

Our studies with rats receiving daily oral or intraperitoneal injections of the aqueous extract of raw garlic for a period of 4 wk produced consistent results. Garlic, when used in either low (50 mg/kg) or high (500 mg/kg) doses, caused a significant reduction in serum cholesterol and triglyceride levels (Figs. 1 and 2). The effect was more pronounced at the high dose of garlic (Fig. 1). In contrast, when boiled-garlic extracts were used in high concentration (500 mg/kg), cholesterol and triglyceride levels were significantly reduced (Fig. 3). However, the percentage of reduction was less than that observed with raw garlic at this dose (Figs 1 and 2).

The results of this study confirm the earlier hypolipidemic effects reported for garlic (18,20). A similar hypocholesterolemic effect of garlic was observed previously in rats fed a high-cholesterol diet in the presence of garlic oil (23).

The results show that an aqueous extract of raw garlic taken in small amounts has a profound effect in lowering cholesterol and triglyceride levels. In contrast, blood-glucose levels do not decrease in rats receiving a low dose of fresh garlic extract. However, high doses of this herb have a significant effect in lowering blood-glucose levels. This study also shows that the effects on triglyceride and cholesterol levels are lowered but not abolished upon boiling the garlic extract. In contrast, the boiled garlic extract lost all effectiveness in lowering serum-glucose levels.

We can therefore conclude that raw garlic is more beneficial than the cooked form in reducing blood lipid and glucose levels, and could potentially play an important role in preventing atherosclerosis or diabetes. Of significance is that one of the chronic complications of diabetes is the increased prevalence of cardiovascular disease (24). Therefore, any agent that has the ability to both lower blood-lipid and glucose levels is a potential preventive agent for diabetics. It is clear from the present results that garlic extracts in modest doses could have a beneficial effect on blood lipids and glucose in health and disease.

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