

AMELIORATED EFFECTS OF *ALLIUM SATIVUM* ON SUBCLINICAL LEAD TOXICITY IN GOATS

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ABSTRACT

The prophylactic efficacy of garlic (*Allium sativum*) to reduce tissue lead (Pb) concentration was evaluated experimentally in goats. Eight crossbred Iranian female goats were divided into two equal groups. Goats of group A received lead acetate orally at the dose rate of 80 mg/kg BW and group B received concurrent lead acetate orally at the dose rate of 80 mg/kg BW and dried garlic powder orally at the dose rate of 45 g/animal/day for 5 days. Mean serum lead concentration in group A goats was 0.13 ± 0.03 $\mu\text{g/ml}$ before lead administration and 0.56 ± 0.04 $\mu\text{g/ml}$ on 5th day, whereas in group B the concentration was 0.11 ± 0.02 $\mu\text{g/ml}$ before treatment and 0.29 ± 0.02 $\mu\text{g/ml}$ on the 5th day. Mean urine lead concentration in group A ranged between 0.05 ± 0.02 $\mu\text{g/ml}$ before lead administration and 0.45 ± 0.07 $\mu\text{g/ml}$ on the 5th day, whereas in group B it was 0.07 ± 0.01 $\mu\text{g/ml}$ before treatment and 4.08 ± 0.93 $\mu\text{g/ml}$ on the 5th day. The mean lead concentrations in bones, lungs, heart, liver, kidneys and skeletal muscles of group A following necropsy were 39.95 ± 6.94 , 0.65 ± 0.06 , 0.46 ± 0.07 , 6.61 ± 0.74 , 19.32 ± 2.17 , 0.27 ± 0.06 $\mu\text{g/g}$ of wet tissue, respectively. The respective values in group B were 17.77 ± 4.12 , 0.20 ± 0.04 , 0.20 ± 0.02 , 1.45 ± 0.30 , 2.37 ± 0.27 and 0.11 ± 0.01 $\mu\text{g/g}$ of wet tissue. Thus, concurrent use of lead acetate and garlic dry powder reduced lead concentration considerably, indicating the potential activity of garlic against lead toxicity in goats.

Key words: *Allium sativum*, lead, goats, blood, urine, tissues.

INTRODUCTION

Lead toxicity is one of the most common poisonings in farm animals (Radostits *et al.*, 2000). It affects each and every organ and system in the body (Goyer, 1990). Several metal chelators have been used to manage lead toxicity in the event of exposure, but none could be found suitable for reducing lead burden in chronic lead exposure (Osweiler, 1999). Moreover, these chelators have a toxic potential in themselves (Gilman *et al.*, 1991) and often fail to remove lead from all body tissues (Bratton *et al.*, 1981; Cory-Slechta *et al.*, 1987).

Hanafy *et al.* (1994) and Senapati *et al.* (2001) reported that garlic decreases lead contents in tissues of lead exposed rats and chicken, respectively. Different results may be expected due to different metabolism in ruminant species. To our knowledge garlic has not yet been used in ruminant species for lead chelation and it seems that the beneficial effects of this chelation may have therapeutic advantages. Moreover beneficial effects of garlic on reduction of lead tissue concentration eventually decrease tissue lead residues and human lead exposure. In this study, dried garlic powder (Garcin, Goldaru, Isfahan, Iran), was tested for its potential to reduce lead content of different tissues during subclinical lead poisoning in goats.

MATERIALS AND METHODS

Eight female crossbred Iranian goats, weighing 20-25 kg were maintained under similar management conditions. All goats were kept under observation for about one month and were housed indoors and fed alfalfa hay *ad libitum*. They were dewormed (Albendazole, 15 mg/kg; levamisole, 7.5 mg/kg) one month prior to the beginning of the experiment. They were divided randomly into two equal groups (Groups A and B). Group A received daily oral doses of lead acetate (dissolved in distilled water) at the rate of 80 mg/kg BW for five consecutive days. Group B received similar doses of orally administered lead acetate concurrent with dried garlic powder dissolved in distilled water at the dose of 45 g/animal/day orally (using a small bore stomach tube) for five consecutive days.

To establish the lead base values of serum and urine in each group, samples of blood and urine were collected on three occasions at 10 days intervals during one month period before commencing the treatments A and B. Mean of lead concentrations in serum and urine samples on three occasions during this period were assigned as pretreatment values. Venous blood samples were taken from jugular vein and urine samples were

collected by urinary tom cat catheter (Kendall Co., Mansfield, MA, USA) and were placed in lead free containers. Blood samples were allowed to clot and serum was separated following centrifugation for 10 minutes at 450g. Serum and urine samples were stored at -20°C until use. During experimental days, all treatments were given early in the morning. Blood and urine samples were collected 6 hours after treatments. Care was taken not to impose undue pain or suffering to animals during the experiments.

All goats were sacrificed and necropsied at the end of experiments. Samples (10 g) of bone (femur), lung, heart, liver, kidneys (cortex) and skeletal muscles were collected separately for measurement of lead concentration, placed in lead free containers and stored at -20°C until analysed. Serum, urine and tissue samples were digested and lead contents were measured using an atomic absorption spectrophotometer (Shimadzu, AA- 670, Kyoto, Japan) (Haneef *et al.*, 1998).

Data were analysed statistically, using analysis of variance for repeated measures for within group and independent T-test for between group comparisons. Level of significance in each test was at $P < 0.05$.

RESULTS

Serum and urine lead concentrations in goats of groups A and B before and after treatment are presented in Table 1. Results revealed that the concurrent use of garlic dry powder and lead significantly ($p < 0.05$) reduced serum lead concentration and significantly ($p < 0.05$) increased urine lead concentration in goats.

Table 2 shows tissue lead accumulation pattern in the experimental goats. Concurrent use of garlic dry powder and lead significantly ($P < 0.05$) reduced tissue lead accumulation.

DISCUSSION

Garlic administered at the dose of 45 g/animal/day produced no clinical signs and the animals maintained their normal appetite. The mean lead levels were increased significantly in serum, urine, bone, lungs, heart, liver, kidneys and skeletal muscles of goats receiving lead acetate alone. However, the concurrent use of garlic dry powder and lead prevented the accumulation of lead in these compartments. Garlic contains sulfur-containing amino acids like S-allyl cystine, S-allyl mercaptocystein and alliin (Horie *et al.*, 1992). Sulfur containing amino acids like cystein have already been reported for their chemoprophylactic use in lead toxicosis (Quarterman *et al.*, 1980; Latta and Donaldson, 1986; Tandon *et al.*, 1988; Rai and Raizada, 1988). The efficiency of garlic was perhaps due to the presence of these sulfur containing amino acids and compounds having free carboxyl (C=O) and amino (NH₂) groups in their structures. These biologically active compounds might have chelated lead and enhanced its excretion from the body, resulting in reduced lead accumulation in tissues. Further, published results also showed that garlic extracts increased the lead concentration in the urine as well as in faeces of rats (Senapati, 1997), lending credence to this hypothesis. Besides chelation, other components of garlic (S-allyl cystein, S-allyl mercaptocystein and some micronutrients) also prevent absorption of lead from the gastro-intestinal tract

Table 1: Serum and urine lead concentrations (mean \pm SD) in lead exposed (A) and lead exposed + garlic treated (B) goats ($\mu\text{g/ml}$)

Groups	Pretreatment	Days of exposure				
		1	2	3	4	5
Serum						
A	0.13 \pm 0.03 ^a	0.23 \pm 0.01 ^b	0.29 \pm 0.04 ^b	0.37 \pm 0.03 ^c	0.48 \pm 0.05 ^c	0.56 \pm 0.04 ^d
B	0.11 \pm 0.02 ^a	0.16 \pm 0.02 ^e	0.20 \pm 0.02 ^f	0.23 \pm 0.02 ^f	0.24 \pm 0.02 ^f	0.29 \pm 0.02 ^g
Urine						
A	0.05 \pm 0.02 ^a	0.18 \pm 0.02 ^b	0.24 \pm 0.04 ^c	0.26 \pm .04 ^{c,d}	0.30 \pm 0.05 ^d	0.45 \pm 0.07 ^e
B	0.07 \pm 0.01 ^a	0.97 \pm 0.44 ^f	1.60 \pm 0.44 ^f	2.32 \pm 0.84 ^f	3.17 \pm 0.94 ^g	4.08 \pm 0.93 ^h

Values in the same column or row with different letters are significantly different ($P < 0.05$).

Table 2: Tissue lead concentrations (mean \pm SD) in lead exposed (A) and lead exposed + garlic treated (B) goats ($\mu\text{g/g}$ of wet tissue)

Groups	Tissues					
	Bone	Lung	Heart	Liver	Kidney	Skeletal muscle
A	39.94 \pm 6.94 ^a	0.65 \pm 0.06 ^a	0.46 \pm 0.07 ^a	6.61 \pm 0.74 ^a	19.32 \pm 2.17 ^a	0.27 \pm 0.06 ^a
B	17.77 \pm 4.12 ^b	0.20 \pm 0.04 ^b	0.20 \pm 0.02 ^b	1.45 \pm 0.30 ^b	2.37 \pm 0.27 ^b	0.11 \pm 0.01 ^b

Values in the same column with different letters are significantly different ($P < 0.05$).

(Crowe and Morgan, 1996). It can be suggested that the ameliorative potential of garlic was perhaps due to combined effects both on metal absorption and its excretion from the body.

Concurrent use of garlic extract and lead acetate in rats was found to reduce lead concentration, indicating the potential therapeutic activity of garlic against lead toxicity (Senapati *et al.*, 2001). Lead concentrations were reduced in muscle and liver tissues of chickens given both lead and garlic simultaneously (Hanafy *et al.*, 1994). Our findings have also revealed that dried garlic powder has the ability to reduce residues of lead in soft tissues (liver, kidneys, lungs, heart, skeletal muscles) as well as in the bone.

It is concluded that garlic can be used for amelioration of lead toxicity in goats. Further studies in ruminants are required to establish the dose and the molecular basis of the anti-toxic mechanism and the components of garlic involved in it.

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