Antioxidant Effect of *Lycopersicum esculentum* on Plasma Superoxide Dismutase, Catalase and Malondialdehyde in Rat Espoused with Lead Acetate

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Abstract

Background: Lead, an example of heavy metals, has, for decades, being known for its adverse effects on various body organs and systems such that their functions are compromised.

Objective: In the present study, the ability of *Lycopersicum esculentum* on decrease toxic effects of lead acetate on plasma superoxide dismutase, catalase and malondialdehyde in Rat. Lead to adversely affect the Liver tissue apoptosis was investigated and *Lycopersicum esculentum*: Source of antioxidants was administered orally to prevent the adverse effects of Pb.

Methods: Eighteen wistar rats, randomized into three groups (n = 6), were used for this study. Animals in Group A served as the control and was drinking distilled water. Animals in Groups B and C were drinking 1% Lead acetate (LA). Group C animals were, in addition to drinking LA, treated with 1.5 ml of *Lycopersicum esculentum* /day. All treatments were for 10 weeks.

Results: The obtained results showed that Pb caused a significant reduction in the liver weight, plasma and tissue superoxide dismutase and catalase activity, but a significant increase in plasma malondialdehyde concentration.

Conclusion: These findings lead to the conclusion that *Lycopersicum esculentum* significantly lowered the adverse effects of Pb oxidative stress.

Keywords: Antioxidant, Lead acetate, *Lycopersicum esculentum*, Reactive oxygen species

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Introduction

Lead, a dangerous heavy metal, is harmful even in small amounts. Nevertheless, humans get exposed to Pb through their environment and diet [1]. The manifestations of Pb poisoning in humans are nonspecific. They may include weight loss, anemia [2, 3], memory loss [4], nephropathy, infertility, liver, testis and heart damages [5] etc. However, oxidation accompanies lead toxicity [6]. *Lycopersicum esculentum* (tomato), on the contrary, is a source of antioxidants [7, 8] and is made up of components very appropriate for detoxification, illnesses prevention [9], attaining growth [10], helping the immunologic system [11], maintaining blood in good state [2], etc. This research, therefore, focuses on whether oral administration of *Lycopersicum esculentum* prevents Pb-induced toxicity or not.

Material and Methods

Eighteen (18) adult male Wistar rats (220±10 g) were used for this study. They were obtained from animal facility of pasture institute of Iran rats were housed in temperature controlled rooms (25°C) with constant humidity (40 - 70%) and 12h/12h light/ dark cycle prior to use in experimental protocols. All animals were treated in accordance to the Principles of Laboratory Animal Care. The experimental protocol was approved by the Animal Ethical Committee in accordance with the guide for the care and use of laboratory animals prepared by Tabriz medical University. All Rats were fed a standard diet and water. The daily intake of animal water was monitored at least one week prior to start of treatments in order to determine the amount of water needed per experimental animal.

Preparation of tomato paste

Tomato paste (TP) was prepared by grinding tomatoes and heating in a water bath for 30 min at 81°C [8].

Grouping of animals and treatment

The rats were grouped into three groups (Groups A, B, and C, n = 6). Animals in Group A served as the control group and were drinking distilled water. Animals in Groups B and C were drinking 1% Pb (II) acetate (LA). Group C animals were, in addition to drinking LA, treated with 1.5 ml of TP/day. All treatments were for 10 weeks.

Animal sacrifice and collection of samples

48 hours after the last treatment, each animal was sacrificed and blood samples were collected via heart puncture. Blood sample obtained from each rat was divided into two: One half in a plain bottle and the other half in an ethylene ediamminetetraacetic acid bottle.

Collection of data and statistical analysis

One testis from each rat was homogenized for tissue superoxide dismutase (SOD), catalase (CAT) and malondialdehyde (MDA) were determined using the method described by Fridovich (1986) [12].

Statistical analysis

All values were expressed as mean ± SD. Differences in mean values were compared using SPSS 11.0 by one-way ANOVA test. $p<0.05$ was considered as statistically significant.

Results

The following results were obtained and are presented as mean ± SEM. Level of significance is taken at "$P < 0.05$" (*) and/or "$P- < 0.01$" (**).

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Plasma SOD activity

Group B showed a significant ($P<0.01$) decrease in plasma SOD activity. Group C was, however, not significantly ($P>0.05$) different from the control in terms of the plasma SOD activity (Table 1).

Plasma CAT activity

Group B showed a significant ($P<0.01$) decrease in the plasma CAT activity. However, Group C showed no significant ($P>0.05$) difference in the CAT activity from the control (Table 1).

Plasma MDA concentration

Group B showed a significant ($P<0.05$) increase in the plasma MDA concentration whereas Group C showed no significant (P-value >0.05) difference from the control (Table 1).

Discussion

The liver has several major functions including the production of bile to break down fat, glycogen storage, decomposition of red blood cells, production of cholesterol, plasma protein synthesis and drug metabolism just to name a few. The latter takes place by a host of specialized detoxification enzymes and pathways that biochemically modify or metabolize xenobiotics to harmless metabolites and other byproducts for clearance from the body [13, 14]. Microarray gene expression analysis has been used to study the effects of toxicants and other environmental stressors on biological systems [15, 16]. Lead-induced oxidative stress in blood and other soft tissues has been postulated to be one of the possible mechanisms of lead-induced toxic effects [17]. Disruption of pro-oxidant/antioxidant balance might lead to the tissue injury. It was reported that lead increased the level of lipid peroxidation [18] and brain thiobarbituric acid-reactive substances and altered the antioxidant defense system [19]. Similar effects were also reported in the hepatic tissues [20]. A number of recent studies confirmed the possible involvement of reactive oxygen species (ROS) in lead-induced toxicity [21]. Several antioxidant enzymes and molecules have been used to evaluate lead-induced oxidative damage in animal and human studies. Reduced glutathione (GSH) and glutathione disulfide (GSSG) concentrations, as well as modifications in superoxide dismutase (SOD) activity are the most frequently used markers in tissues or in blood. Based on the observation that free radical was generated during the pathogenesis processes induced by lead exposure, it was presumed that supplementation of antioxidants could be an alternative method for chelation

Table 1: measure of plasma; SOD, CAT, MDA in all experimental and control group.

Group	Plasma SOD	Plasma CAT	Plasma MDA (mmol/l)
Control	1.958 ± 0.05	0.3874 ± 0.03	0.25±0.04
1% Lead acetate	1.124 ± 0.05	0.2440 ± 0.02**	4.1±0.06
1% Lead acetate + 1.5 ml of Tomato	1.883 ± 0.06	0.3752 ± 0.01	2.1±0.06

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therapy [22]. Specifically, ascorbic acid, the known chelating agent with antioxidant features, was widely reported with the capability of protecting cells from oxidative stress [23]. More importantly, due to the presence of health-protective antioxidants such as lycopene, vitamin C, and vitamin A in TP [8], despite its relatively low caloric value (21 Kcal/100 g) and low protein content (0.85% by weight) [19]. There was no significant (P >0.05) difference in the SOD activity of the plasma of the control and that of the animals treated with tomato along with Pb. But, there was a significant (P-value <0.01) decrease in the plasma SOD activity in animals treated with Pb only compared with the control. This finding is in agreement with that of Ping-Chi and Yueliang (2002) [24], and is at the same time in support of *Lycopersicum esculentum* (tomato) as an antioxidant. There was a significant (P <0.05) decrease in plasma CAT activity of animals treated with Pb only relative to the control. There was, however no significant (P>0.05) difference between the control and the animals treated with tomato along with Pb in this respect. This further establishes that TP must have reduced the oxidative stress that Pb could cause. Finally, there was no significant (P-value >0.05) difference in both the plasma and the testicular MDA concentration of the control and those of the animals treated with tomato along with Pb, whereas animals treated with Pb only showed a significant (P<0.05) increase in plasma MDA concentration. This confirms that it was TP, the source of antioxidants [7, 8], that reduced the oxidative stress that Pb exposure could have caused in the tomato-treated animals. Free radical-induced oxidative damage has been implicated in the pathogenesis of a number of injury and disease states. We have previously found that ROS played a pivotal role in apoptosis of testis cells in lead-exposed mice [25]. ROS, which was predominantly produced in the mitochondria, led to the free radical attack of membrane phospholipids and loss of mitochondrial membrane potential, which caused the intermembrane proteins, such as cytochrome c, to be released out of the mitochondria and ultimately triggered caspase-3 activation. Caspase-3 activation led to DNA breakage, nuclear chromatin condensation and cell apoptosis [25, 26]. In summary, *Lycopersicum esculentum* can lessen the oxidative damage induce by lead, but the antioxidant effects are dependent on their concentrations.

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