Comparative study on Antioxidative activity of onion (Alliums cepa. Linn) versus zinc sulfate supplementation in rats

DATASET · SEPTEMBER 2013

3 AUTHORS:

Jamshid Ghiasi Ghalehkandi
Islamic Azad University Shabestar Branch
90 PUBLICATIONS  44 CITATIONS

Rahim Beheshti
Islamic Azad University Shabestar Branch
46 PUBLICATIONS  27 CITATIONS

Naser Maheri-Sis
Islamic Azad University, Shabestar Branch, …
68 PUBLICATIONS  100 CITATIONS
Comparative study on Antioxidative activity of onion 
(*Alliums cepa. Linn*) versus zinc sulfate supplementation in 
rats

Jamshid Ghiasi Ghalehkandi (Corresponding author)
Department of Animal Science, Islamic Azad University, shabestar branch, 53815-159 Shabestar, Iran
Tel: +98 914 401 2714 E-mail: ghiasi_jam@yahoo.com

Rahim Beheshti
Department of veterinary Science, Islamic Azad University, shabestar branch, 53815-159 Shabestar, Iran

Naser Maheri Sis
Department of Animal Science, Islamic Azad University, shabestar branch, 53815-159 Shabestar, Iran

Abstract
Many traditional treatments have been recommended in the complementary medicine for treatment of Diabetes Mellitus; however, the mechanism of most of the herbals used has not been defined. *Allium* is a genus of some 500 species belonging to the family Liliaceae. The aim of this study was to determination of the Antioxidative activity of onion alone and in combined use with zinc sulfate. In this experiment, 162 mature male rats (250 gm on the average) were acquired from Razi Serum–producing Institute of Karaj and transferred to keeping place and then divided into the 9 identical groups. It showed that onion alone results in increase in CAT, GPX and SOD content of serum. Also yields to decrease in MDA content. This activity of the onion was potentiated in combined use with zinc sulfate. Onion and zinc sulfate have the most important antioxidant contents that combined use of these elements showed best effect than alone use.

Key words: antioxidants, onion (*Allium cepa. Linn*), zinc sulfate, MDA, SOD, GPX, CAT.

1. Introduction
Antioxidant enzymes, i.e. superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), operate in concert together with several non-enzymatic molecules to contrast the ROS actions and to avoid oxidative damage. SOD catalyzes the reduction of superoxide anion into hydrogen peroxide, which is subsequently detoxified by CAT and GPx at both intra- and extracellular levels. Three different isoforms of SOD have been identified: SOD1 (Copper Zinc-SOD, CuZn-SOD), localized in cytoplasm, which includes Cu and Zn at its catalytic site, SOD2 (Manganese-SOD, Mn-SOD), localized in mitochondria, which have Mn as a co-factor, and finally SOD3 (EC-SOD), an extracellular antioxidant enzyme, which, such as SOD1, presents Cu and Zn at its catalytic site. Other transition metals are important components of the enzymatic antioxidant defenses: Cu and iron (Fe) are, in fact, essential components of CAT, and selenium (Se) is a constitutive component of GPx. Consequently, metal ions are crucial for life. In particular, Zn has several antioxidant properties other
than being co-factor of SOD1 and SOD3, such as maintenance of protein sulphydryl groups (Bray and Bettger, 1990; Powell, 2000), protection against vitamin E depletion, stabilization of membrane structure, and the maintenance of tissue concentrations of metallothioneins, powerful free radical scavengers (DiSilvestro, 2000). Therefore, Zn supplementation may be beneficial in guaranteeing powerful antioxidant defenses.

Dietary factors play a key role in the development of various human diseases, including cardiovascular and other metabolic diseases, atherosclerosis, hyperlipidemia thrombosis, hypertension and diabetes (Banerjee and Maulik, 2002). Medicinal plants continue to provide valuable therapeutic agents, in both modern medicine and in traditional system. Allium species such as onions and garlic are used as foodstuff, condiment, flavoring, and folk medicine. Garlic has attracted particular attention of modern medicine because of its widespread health use around the world, and the cherished belief that it helps in maintaining good health, warding off illnesses and providing more vigor. The biological responses of onion have been largely attributed to (i) reduction of risk factors for cardiovascular diseases and cancer, (ii) stimulation of immune function, (iii) enhanced detoxification of foreign compound, (iv) hepatoprotection, (v) antimicrobial effect and (vi) antioxidant effect (Banerjee and Maulik, 2002).

Onion was also a popular folk remedy. It is rich in flavonoids such as quercetin and sulfur compounds, such as allyl propyl disulphide that have perceived benefits to human health (Griffiths et al., 2002). In addition, onion and garlic are rich in sulfur containing compounds mainly in the form of cysteine derivatives, viz. S-alkyl cysteine sulfoxides which are decomposed the enzyme allinase into a variety of volatile compounds such as thiosulfates and polysulfides during extraction. These compounds possess antidiabetic, antibiotic, hypocholesterolaemic, fibrinolytic, and various other biological effects. In addition to volatile substances in alliums, there are nonvolatile sulfur-containing peptides and proteins which have been shown to have potential health benefits (Augusti, 1996). Therefore, the purpose of the present study was to examine the influence of oral administration of onion on the levels of free radicals, biochemical parameters, and the activities of some enzymes in plasma in the experimental models.

2. Materials and methods

In this experiment, 162 mature male rats (250 gm on the average) were acquired from Razi Serum–producing Institute of Karaj and transferred to keeping place. This design is performed as a factorial experiment 3*3 (3 level of onion extract and 3 level of zinc sulfate complement) in the form of totally random design with 9 groups per 3 replications each containing 6 rats. All of keeping cages were disinfected before performing the experiment.

All of groups were kept in 12-hour light and 12-hour darkness conditions with 25-30°C temperature and free access to water and food in metal cages placed in animal husbandry of veterinary faculty of Islamic Azad University, Tabriz Branch.

Fresh onions were used in this experiment, and onion extract was obtained through soxhlet apparatus in combination with deionized distilled water within 6 hours in two successive days at 30°C (to prevent elements and materials of garlic from decomposition).

Then, the extract was placed in incubator in order to be concentrated. Certain concentrations of garlic extract were dissolved in pure water and became reachable by rats on a daily basis. Chromium chloride complement was acquired (from Germany Merk) and after measuring certain rat by digital scale was given to mice on a daily basis.

It must be mention that onion extract was give as gavages (gastro–oral) and zinc sulfate complement was dissolved in water in certain amount and it was added to food after steeping and powdering of pellets, then the food was mixed, ground and dried, and obtained pellets was given to animal.
Moreover, during the first week of experiment, all groups consumed basal diet in order to adapt with breeding environment conditions then groups were divided as follow:

Groups 1: basal diet,
Groups 2: basal diet + 1cc fresh onion extract,
Groups 3: basal diet + 2cc fresh onion extract,
Groups 4: basal diet + 15 mg/ kg zinc sulfate complement,
Groups 5: basal diet + 30 mg/ kg zinc sulfate complement,
Groups 6: basal diet + 1cc fresh onion extract + 15 mg/ kg zinc sulfate complement,
Groups 7: basal diet + 1cc fresh onion extract + 30 mg/kg zinc sulfate complement,
Groups 8: basal diet + 2cc fresh onion extract + 15 mg/ kg zinc sulfate complement
Groups 9: basal diet + 2cc fresh onion extract + 30 mg/kg zinc sulfate complement.

The above mentioned groups were treated for 4 weeks. At the end of fourth week, after 12 hours starvation, 6 rats were selected randomly from every treatment and their blood sampling was done through decapitation, then serum concentrations of the malondialdehyde (MDA), catalase (CAT), glutathione peroxidase (GPX), and superoxide dismutase (SOD) were measured.

2.1. Statistical Analysis
The results of the research have been statistically analyzed using the linear model of SAS software (SAS, 2001).

Analysis of variance according to the model,

\[ Y_{ijk} = \mu + T_i + K_j + (S \times K)_{ij} + E_{ijk} \]

Where,
\( x_{ij} = \) All dependent variable
\( \mu = \) Overall mean
\( T_i = \) The fixed effect of perlit levels (i = 1, 2, 3 )
\( e_{ij} = \) The effect of experimental error

Values of different parameters were expressed as the mean ± standard deviation (X±SD). When significant difference among means was found, means were separated using Duncan’s multiple range tests.

3. Results
By comparison of the treatment groups (Table 1), observed that treatment 9 had the greatest effect on serum antioxidant factors.

In the table, it shows that onion alone results in increase in CAT, GPX and SOD content of serum so this is significant in group 3. Also yields to decrease in MDA content significantly in group 2.

Zinc sulfate supplementation alone results in increase in SOD content of serum significantly in group 5. Also yields to decrease in MDA, CAT and GPX content significantly in group 4.

Our study showed that Combination administration of onion plus Zinc sulfate supplementation cause to decrease MDA and increase CAT, GPX, and SOD.
4. Discussion and conclusion

In the present study different concentrations of aqueous extracts of onion and zinc supplementation caused a significant decrease of serum malondialdehyde perhaps because the onion and zinc can act as an antioxidant in the blood. In addition, previous studies showed that zinc (as an antioxidant) resulted in significant increase in selenium content of meet and blood (boa et al., 2005). In the one study by the karamoze et al., 2009 was determined that different levels of zinc oxide supplementation reduce serum concentrations of malondialdehyde and increase in total serum antioxidants in broilers. Bonet et al., 2012 in a study showed that zinc as vitamin E reduces damage caused by peroxidation of cell membranes.

Helen et al., 2000 worked on Antioxidative activity of onion and she demonstrate that onion oil supplemented to nicotine treated rats showed increased resistance to lipid peroxidation and the effect was near to that of vitamin E fed rats. The activity of catalase and superoxide dismutase decreased in nicotine treated rats. Antioxidants-glutathione content, vitamin C and retinol showed no significant difference but liver vitamin E content significantly decreased in nicotine treated rats. On onion oil or vitamin E supplementation, the concentration of antioxidants were significantly raised in all the tissues studied, however, a significantly increased concentration of glutathione, vitamin E and retinol was noticed in vitamin E+nicotine treated rats. Thus, these results indicate that onion oil is an effective antioxidant against the oxidative damage caused by nicotine as compared to vitamin E.

Campos et al., 2003 showed that hypoglycaemic and hypolipidaemic actions of A. cepa were associated with antioxidant activity, since onion decreased superoxide dismutase activities while no increased lipid hydroperoxide and lipoperoxide concentrations were observed in diabetic rats treated with A. cepa.

McAnlis et al., 1999 declare that Quercetin from the onion can be absorbed in humans from dietary sources to high enough concentrations to increase the overall antioxidant activity of the plasma. Quercetin, however, has a strong affinity for protein and provides no direct protective effect during LDL oxidation.

The results of Yamamoto et al., 2005 research suggest that the green-leafy Welsh onion, but not the white type, reduced superoxide generation by suppressing the angiotensine II production and then the NADH/NADPH oxidase activity, increasing the NO availability in the aorta, and consequently lowering the blood pressure in the rats fed with the HFS diet. The radical scavenging and reducing antioxidative activities of green Welsh onion may also be effective in decreasing superoxide.

As mentioned above, Yang et al., 2012 reported that fermentation raised the quercetin content in onion, and subsequently increased the antioxidative and neuroprotective activities.

The beneficial effect of adequate Zn level on Cd toxicity was confirmed by a significant decrease in TBARS level and restoration of chlorophyll content. However, when Zn was added at high level in combination with Cd there was an accumulation of oxidative stress, which was higher than that for Cd or excess Zn alone treatments. These results suggested that higher Zn concentrations and Cd are synergistic in their effect on plant growth parameters and oxidative stress (Cherif et al., 2011).

Arda-Pirincici et al., 2009 indicated that zinc sulfate has a protective effect against ethanol-induced intestinal injury. In addition, the protective effect of zinc on ethanol-induced intestinal injury might be mediated by metallothionein, as well as having antioxidative potential.

Zinc supplementation to lithium-treated rats effectively raised the reduced glutathione levels and also normalized lipid peroxidation and the activities of antioxidative enzymes, which included catalase, glutathione S-transferase, and superoxide dismutase. Moreover, zinc supplementation could raise the activities of the enzymes aminolevulinic acid dehydratase and Na(+) K(+) adenosine triphosphatase as
well as the percentage uptake values of (65)Zn in blood and its fractions. The study suggests that zinc, as a nutritional supplement, has the potential in attenuating most of the adverse effects induced by lithium in rat blood (Malhotra and Dhawan, 2008).

In one other study by Arda-Pirincci et al., 2006 revealed that zinc sulfate has a protective effect against ethanol-induced acute gastric damage. In addition, they might say that the zinc given as exogenous protection against acute gastric damage has a protective effect both by stimulation of metallothionein synthesis and through GSH as well as having antioxidative potential.

Zinc supplementation ameliorates lead-induced testicular damage both at the cellular and subcellular level. The protective effect of Zn may be due to Antioxidative effect of this element (Batra et al., 1998).

In one study by Barollo et al., 2011 revealed that Zn acetate offers marginal benefit in colitis severity.

Rogalska et al., 2011 worked on protective effect of zinc against cadmium hepatotoxicity depends on this bioelement intake and level of cadmium exposure and they results provide strong evidence that enhanced Zn consumption may be beneficial in protection from Cd hepatotoxicity; however, its excessive intake at relatively high exposure to Cd may intensify liver injury.

By comparison of above mentioned literatures it has been revealed that onion and zinc sulfate have the most important antioxidant contents that combined use of these elements showed best effect than alone use.

References


Table 1. Comparison of MDA (nmol/ml) and catalase, glutathione peroxidase and superoxide dismutase (international units per gram of hemoglobin)

<table>
<thead>
<tr>
<th></th>
<th>MDA</th>
<th>CAT</th>
<th>GPX</th>
<th>SOD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Onion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>4.47 a</td>
<td>68.23 a</td>
<td>1560.27 a</td>
<td>1894.33 a</td>
</tr>
<tr>
<td>Group 2</td>
<td>3.06 b</td>
<td>72.57 b</td>
<td>1640.65 a</td>
<td>1964.40 b</td>
</tr>
<tr>
<td>Group 3</td>
<td>3.15 b</td>
<td>78.18 b</td>
<td>1698.03 b</td>
<td>1972.41 b</td>
</tr>
<tr>
<td>P-value</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>SEM</td>
<td>0.04</td>
<td>3.2</td>
<td>12.4</td>
<td>32.10</td>
</tr>
<tr>
<td><strong>Zinc sulfate supplementation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>3.77 a</td>
<td>84.82 a</td>
<td>1623.65 a</td>
<td>1912.64 a</td>
</tr>
<tr>
<td>Group 4</td>
<td>3.15 b</td>
<td>55.69 b</td>
<td>1608.85 b</td>
<td>1942.52 b</td>
</tr>
<tr>
<td>Group 5</td>
<td>3.76 b</td>
<td>66.33 b</td>
<td>1559.45 b</td>
<td>1946.98 b</td>
</tr>
<tr>
<td>P-value</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>SEM</td>
<td>0.02</td>
<td>4.2</td>
<td>18.13</td>
<td>26.36</td>
</tr>
<tr>
<td><strong>Combination administration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onion</td>
<td>Zinc sulfate supplementation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 cc 0 (control)</td>
<td>4.15 a</td>
<td>62.20 a</td>
<td>1694.26 a</td>
<td>1973.31 a</td>
</tr>
<tr>
<td>15 mg /kg</td>
<td>3.35 b</td>
<td>80.75 b</td>
<td>1699.91 a</td>
<td>2005.88 ab</td>
</tr>
<tr>
<td>30 mg /kg</td>
<td>3.10 b</td>
<td>82.75 b</td>
<td>1715.66 b</td>
<td>1998.80 ab</td>
</tr>
<tr>
<td>1 cc 0 (control)</td>
<td>3.05 c</td>
<td>88.25 b</td>
<td>1700.02 b</td>
<td>2000.13 b</td>
</tr>
<tr>
<td>15 mg /kg</td>
<td>2.55 c</td>
<td>90.00 bc</td>
<td>1817.75 c</td>
<td>2169.10 c</td>
</tr>
<tr>
<td>30 mg /kg</td>
<td>2.00 d</td>
<td>94.00 bc</td>
<td>1836.18 c</td>
<td>2010.97 cd</td>
</tr>
<tr>
<td>2 cc 0 (control)</td>
<td>3.10 b</td>
<td>95.25 bc</td>
<td>1841.68 c</td>
<td>2096.46 cd</td>
</tr>
<tr>
<td>15 mg /kg</td>
<td>2.55 c</td>
<td>102.00 cd</td>
<td>1921.90 d</td>
<td>2163.60 cd</td>
</tr>
<tr>
<td>30 mg /kg</td>
<td>2.90 dc</td>
<td>122.33 dc</td>
<td>1932.50 d</td>
<td>2221.17 cd</td>
</tr>
<tr>
<td>P-value</td>
<td>**</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>SEM</td>
<td>0.90</td>
<td>3.04</td>
<td>11.20</td>
<td>13.10</td>
</tr>
</tbody>
</table>