Effect of Aluminium Chloride and Protective Effect of Ginger Extract on Hematological Profiles in Male Wistar Rats

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Abstract
The present study was planned to investigate the effect of aluminium chloride and the protective effect of ginger extract on hematological profiles in male rats. One group of rats was given aluminium chloride orally (100mg/kg bw) for 60 days, another group with aluminium chloride and ginger extract (50mg/kg bw) simultaneously and the third group with ginger extract alone. All the three groups were compared with one control group. The hematological parameters were: total erythrocytes count (RBC), White blood cells (WBC), hemoglobin(HB), hematocrit (HCT), and red blood indices: mean corpuscular volume (MCV) mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHV) was investigated. The obtained results showed significant increase in WBC count and decrease in HCT, HB and RBC. No change was noted in (MCV) and there was reduction in mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHV) in AlCl3 administered group (E1). However, no appreciable changes were noted in AlCl3 and ginger extract treated (E2) and Ginger alone treated group (E3). The changes in the values of blood indices may be a defensive mechanism against aluminum toxicity through stimulation of erythropoisis. It may be concluded that Ginger rich in antioxidant and also spicy content which is safety food for human consumption. This study showed that hematologic effects of AlCl3 are reversible by aqueous ginger extract.

1. INTRODUCTION
The increase in pollution is a major global problem and this is due to the use of toxic chemicals or xenobiotic substances or by certain synthetic compounds such as heavy metallic compounds1,2. Aluminum (Al) is the third most prevalent and the most abundant metal in the earth’s crust, representing approximately 8% of total mineral components3. Al components are primarily found in corn, yellow cheese, salt, herbs, spices, tea. It is widely used in cosmetics, cookware utensils and containers, food additives and toothpaste4 and used in medicines, e.g., antacids, phosphate binders, buffered aspirins, vaccines and injectable allergens5 and also added to drinking water for purification purposes6. Recently, increased attention is being paid to aluminum due to its serious effects on the central nervous system, energy metabolism and hematology. The different forms of Al have been shown to be systemic toxicants7 and there is now considerable evidence demonstrating that the accumulation of Al in body tissues is associated with damage to the target organs8,9. Blood, which rapidly and constantly flows through the brain and other body organs and play an important role in the transportation of nutrients, antioxidants, hormones and some other chemicals. Once in the blood circulation, Al is mainly transported by plasma transferrin in its sites left vacant by iron, and to a much lesser extent by albumin10. Hematological and biochemical profiles of blood can provide important information about the internal environment of the organism7. Hematological parameters as red blood cells counting (RBC), hemoglobin concentration (HB), hematocrit (HCT), leukocytes, neutrophils and mononuclear cells counting and Mean Corpuscular Volume (MCV) are largely applied to diseases diagnostics, including effects due to exposure to toxic substances. Now a day’s lot of research has been conducted on the use of herbal products as natural antioxidants because of their fewer side effects, easy and cheap availability. Medicinal plants have been used in various traditional systems, as they have immune potential against numerous diseases11. Ginger (Zingiber officinale) is commonly used as food spice since in ancient times12. It has long been used as a remedy for common ailments like digestive problems, cold, fever, morning sickness. All major active ingredients of ginger such as zingerone, gingerodil, zingibrene, gingerol and shogaols have antioxidant activity13. Studies have revealed a wide range of pharmacological effects demonstrated are anti-platelet, antioxidant, anti-tumour, anti-rhinoviral, anti-hepatotoxicity and anti-arthritic effect14-20. Ginger can be successfully used as a component of curry powder, sauces, ginger bread and ginger flavoured carbonated drinks and in preparation of dietaries for its aroma and flavor. With regard to antioxidant properties of ginger, it can be selected for this study to evaluate the ameliorative effects. Therefore, the present study was carried out to investigate the effect of aluminium chloride in blood hematological profile and the possible protective effect of ginger extracts on it.

2. MATERIALS AND METHODS
2.1 Animals
Adult albino rats (Wistar strain) weighing 250-260g were used in this study. Animals were maintained as per the guidelines of the Institutional Animal Ethical Committee (IAEC). All the animals were housed in polypropylene cages at standard husbandry conditions (Temperature: 23 ± 2°C, Relative humidity: 60-70%, 12h: 12h light /dark cycle) and were provided with standard pellets and water ad libitum. They were initially acclimatized for the study. The experimental protocols were approved by the Institutional Animal Ethical Committee (IAEC) Approval No 140/PHARMA/SCRI, 2013. After 15 days adaptation period the rats were divided into four groups of 6 animals each.

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2.1 Experimental groups

Group I – Control group
Rats given water as vehicle orally, daily for 60 days.

Group II – Experimental group I (E1)
Rats given aluminium chloride (100 mg/kg body weight) orally, daily for 60 days.

Group III – Experimental group II (E2)
Rats given aluminium chloride 100 mg/kg body weight simultaneously with ginger extract (50mg/kg body weight) orally, daily for 60 days.

Group IV – Experimental group III (E3)
Rats given aqueous ginger extract (50mg/kg body weight) orally, daily for 60 days.

During the treatment period, the feed consumed every day was recorded and the body weight was taken on every day and the percent changes were calculated. The animals were treated in the morning. 24 hours after the last treatment, blood samples were collected from the retro-orbital sinus of all animals at the end of the experimental period and EDTA was used as an anti-coagulant. Noncoagulated blood was tested, shortly after collection, for hemoglobin (HB), White blood cells (WBC), Red blood cells (RBC), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) using Hematoanalyzer (Siemens).

3. RESULTS

Table 1 shows the results of total WBC, RBC, hemoglobin (HB), hematocrit (HCT), and red blood cell indices (MCV, MCH and MCHC) in all groups of rat. The present study reveals that, aluminium chloride administration showed significant elevation in WBC (p<0.01) and decline in RBC (p<0.01), HB (p<0.01), HCT (p<0.05) (Fig- 1 and 2). No change was observed in MCV and non significant decrease was noted in MHC and MCHC (Fig-3). On the other hand, administration of ginger extract simultaneously with Al treated animals showed the normal levels similar to control animals. Furthermore, the animal treated with aqueous ginger extract alone does not produce any alteration in all these parameter when compared to control animal.

Table 1: Changes in Hematology and RBC’S indices (MCV, MCH, and MCHC) of the aluminium and ginger treated groups compared to control group.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control</th>
<th>AlCl3</th>
<th>AlCl3 + Ginger</th>
<th>Ginger alone</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC (×10^9/L)</td>
<td>6.2 ± 0.326</td>
<td>8.4 ± 0.559 **</td>
<td>5.1 ± 0.664</td>
<td>6.7 ± 0.393</td>
</tr>
<tr>
<td>RBC (×10^12/L)</td>
<td>5.57 ± 0.383</td>
<td>4.49 ± 0.483 **</td>
<td>5.39 ± 0.178</td>
<td>5.5 ± 0.327</td>
</tr>
<tr>
<td>HB (g/dL)</td>
<td>9.08 ± 0.660</td>
<td>7.69 ± 0.753 **</td>
<td>8.86 ± 0.308</td>
<td>9.2 ± 0.632</td>
</tr>
<tr>
<td>HCT (%)</td>
<td>27.0 ± 1.796</td>
<td>23.23 ± 1.334 *</td>
<td>25.84 ± 0.861</td>
<td>27.4 ± 1.704</td>
</tr>
<tr>
<td>MCV (fL)</td>
<td>48.6 ± 1.684</td>
<td>46.21 ± 0.736</td>
<td>47.23 ± 0.547</td>
<td>49.0 ± 0.280</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>15.6 ± 0.736</td>
<td>16.6 ± 0.231</td>
<td>16.4 ± 0.225</td>
<td></td>
</tr>
<tr>
<td>MCHC (g/dL)</td>
<td>33.4 ± 0.254</td>
<td>32.7 ± 0.266</td>
<td>34.2 ± 0.330</td>
<td>33.5 ± 0.369</td>
</tr>
</tbody>
</table>

The results are expressed as Mean ± SEM (n = 6) per treatment and respective control groups. Levels of significance values are *p<0.05, **p<0.01, ***p<0.001 compared with control group. P <0.05 considered to be statistically significant.

4. DISCUSSION

Among toxic environmental metals, Al has a remarkable toxic potential for humans. After long term exposure of Al may cause deleterious effect on the morphology and physiology of blood cells. Hematological parameter namely PCV, HB, RBC, WBC and differentials were monitored during the chronic toxicity study in rats because of their role in providing reliable information concerning hematological changes toxicants could cause. The evaluation of hematology and biochemical characteristics has become an important health indicators and means of understanding normal and pathological processes and toxicological impacts.

Our study results indicated that Al administration showed significant decline in the concentration of HB, RBC, HCT, etc. It is suggestive that altered peripheral blood composition is a reflection of disrupted hematopoietic process and interfering with different stages of red-cell synthesis and mature red blood cells. However, Al-induced hematological alterations leading to microcytic hypochromic anemia in albino rats on the same blood parameters in rats.

Fig.1 and 2: demonstrates the significant changes in the Hematology parameter (WBC, RBC, HB and HCT) of Aluminium administered and ginger treated group compared to control animals.

Fig.3: Illustrates the significant change in the RBCs indices (MCV, MCH and MCHC) of Aluminium administered and ginger treated group compared to control animals.
deformability and significant increments in whole blood viscosity where the animals were treated with 5mg Al(SO4)2*4H2O for 2 weeks. The white blood cells are the regulators of the immune system and the increase in WBCs count may be due to generalized immune responses and a protective response to metals stress. In general, stimulation of lymphopoiesis and/or enhanced release of lymphocytes from lymphoid tissue under toxic stress may lead to an increase in WBCs number. The increased level of WBC in the blood of C. gariepinus collected from El-Rahawy drain and this attributed to expose to chronic sewage, and increased WBCs count in fish exposed to copper indicates leucocytosis. The primary function of erythrocytes is to carry oxygen binding to HB from the lungs to tissues. Furthermore, HB in erythrocytes is an excellent acid-base buffer (for the majority of proteins), thus erythrocytes are mostly responsible for the buffer capacity of whole blood. Significantly decreased HB levels were seen in the Swiss Albino mice after long-term groundwater exposure (180 days) due to heavy metal toxicity. Decreased HB% as well as PCV was observed in wild Libyan Jird, Meriones libycus treated with mixture of lead, copper, mercury via drinking water in Riyadh. Hematocrit (HCT) is used to measure the blood carrying capacity and it is directly associated with the HB% and RBC ability to conduct tissue oxygenation activity. Therefore, HCT shares the reasons for cause of fall in its level with HB% declination in this study. Decrease in HCT may be due to suppresses of bone marrow hematopoietic system. Causing iron deficiency in synthesis of Hb and protein of Hemoglobin. The low HCT would indicate anaemia or oligohaeamia. The changes in the blood HCT value has often been shown to be a good indicator of aluminum toxicity. Short term exposures to low concentrations of heavy metals mostly induce an increase in the hematological indices. Oliveira Ribeiro et al., observed increase in red blood cells counts in H. malabaricus exposed to Methylmercury (MeHg) and attributed this to an increase in the blood oxygen carrying capacity. The RBCs may also be affected in O. mykiss after an acute exposure to Al. Further, significant decrease in RBC count and HB were seen in rats and human with high blood lead levels. Significantly decreased RBC, HB levels and HCT values were observed in rats exposed to lead and in Salmo gairdneri blood exposed to cadmium. Moreover, exposure of Zn to Oncorhynchus kisutch caused decrease in HB and HCT values. The reduction in RBCs, HB and HCT might be due to an inhibition of erythropoiesis and hemoglobin synthesis and to an increase in the rate of erythrocytes destruction. Several mechanisms have been proposed for the Al-induced anemia, and the proposed mechanisms appear to involve inhibition of heme synthesis, either by inhibition of enzyme activity or interference with iron incorporation or utilization. JadHAV et al. (2007), have reported decreased RBC count after exposing a mixture of heavy metals including (Pb, Cd, Fe, Zn, Cu) in wistar rats. Heavy metal toxicity suppresses the hematopoietic system. Another reason may be decline in erythropoietin synthesis and secretion. In the absence of this hormone, RBC productions were decline considerably. The MCV gives an indication of the status or size of the red blood cells and reflects an abnormal or normal cell division during the summation of monocytes, eosinophils and basophils in their work on effects of onion and garlic extracts on some immunologic cells. Yin et al., reported that oral administration of ginger (Zingiber officinale) extract increases the phagocytic capability of cells in rainbow trout. Thus increasing lymphocytes count in the blood following increase in white blood cells count can play an important role in stimulating the immune system of animals. The increase in white blood cells count represents stimulation of the host's immune system. In other words, anti-viral, anti-bacterial and anti-fungal properties of medicinal plants and symbiotics can be effective in improving immune function and may make the environment unfavorable for invading foreign agents. Herbal immuno-stimulants are substances which activate blood cells (WBCs) and may render fishes more resistant to infectious diseases, by the stimulating phagocytic cells as well as complement lysozyme and antibody responses. Thus, the present study has, however, demonstrated that Al induced anemia can be reversed by the supplementation of ginger extract.

5. CONCLUSION

Considering the importance of white blood cells and role of red blood cells in daily human life, the present study was carried out. It was evident in the study that the long term exposure of Al was able to induce the changes in hematological parameters. Any changes made in their structure and number can cause very large physiological changes for animals. On the other hand, supplement administration of ginger extract reversed the Al toxicity effects to the normal level similar to that of control animals. Thus, the present study explores the possibility AI induced anemia can be reversed by the supplementation of ginger extract in rats.

REFERENCES


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