Protective Role of Lycopene against Cadmium Induced Haematological Changes in Swiss Albino Mice

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Research Article

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ABSTRACT :

Cadmium is one of the toxic, hazardous metals widely dispersed in the environment in high levels. The aim of the present study is to evaluate the role of lycopene on hematological parameters in cadmium exposed mice. Albino mice were divided into four groups. Group I were control mice, group II received cadmium (0.32mg/kg bw) only, group III received olive oil (20mg/kg bw) only and group IV received an acute dose of cadmium followed by daily administration of lycopene (20mg/kg bw) for 15 days. On the day of autopsy blood samples were collected into ethylenediaminetetra acid (EDTA) bottles, for assessing hemoglobin (Hb), red blood cell (RBC), packed cell volume (PCV), white blood cell count (WBC) and WBC differentials, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC). The results showed significant reduction in hemoglobin level, RBC and WBC count and all the hematological parameters in cadmium treated mice as compared to control. Administration of lycopene reversed almost all the abnormalities in the blood parameters showing significant protection against cadmium induced toxicity in mice. It is concluded that lycopene showed affordable protection against cadmium induced toxicity on blood profile.

Keywords: Cadmium (Cd), Lycopene and Hematological parameters.

INTRODUCTION:

Cadmium (Cd) has been in industrial use for a long period of time. Its serious toxicity moved into scientific focus during the last century. Cadmium is regularly found in ores together with zinc, copper and lead. Therefore volcanic activity is one natural reason for a temporary increase in environmental cadmium concentrations. The most dangerous characteristic of cadmium is that it accumulates in various tissues and the major target organs are liver and kidney. It has a very long biological half – life (17 to 30 years) in humans.[1, 2]

Cadmium has been recognized as a biological toxicant.[3] It is associated with several clinical complications like, bone abnormalities, haematological alterations, renal & hepatic dysfunctions etc.[4] A study conducted on rats has also reported that there is a significant decrease in the red blood cell (RBC) count & haemoglobin (Hb) concentrations, packed cell volume (PCV), mean corpuscular volume (MCV) & mean corpuscular haemoglobin (MCH), leading to anemia, on cadmium exposure.[3] This might be due to the fact that cadmium on entering into the blood stream, binds to the erythrocyte membranes causing increased haemolysis &destruction, leading to alterations in the haematological parameters.[5] But the production of reactive oxygen species (ROS) can be attributed to one of the most common causes for the reduction in the haemoglobin concentration which also results in the destruction of the red blood cell membrane and its functions.[3]

Blood is the most accessible sample one can obtain for analysis. It consists of 45% cells and 55% plasma. Red blood cells (RBC) constitute 99% of its cellular components. They mainly govern the blood behavior either rheologically [6] or electrically.[7] RBC is a biconcave enucleated cell containing haemaglobin molecules. Several types of analysis can be performed to investigate the effect of cadmium on blood.

Lycopene is a carotenoid without any provitamin-A activity and cannot be synthesized but can be stored in human body.[8] Lycopene acts as a therapeutic agent and may alleviate chronic diseases such as coronary heart diseases, eye disease, male infertility, inflammation and osteoporosis. Experimental and epidemiological studies have also established its role in the management of diabeties and hepatoprotection. No adverse effects have been reported with the consumption of lycopene-containing foods.[9]

Therefore in the present investigation, protective effects of lycopene against cadmium induced hematological changes in Swiss albino mice have been studied.

MATERIALS AND METHODS

Animals: Swiss albino mice weighing 20±2g were procured from GADVASU, Ludhiana. They were kept and acclimatized to the laboratory conditions for 15 days under

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Conflict of interest: Authors reported none

optimal conditions of light and temperature. They had *ad libitum* access to tap water. The animals were handled with humane care in accordance with the guidelines of the Institutional Animal Ethical Committee.

Chemicals: Cadmium chloride ($CdCl_2$) was bought from S.D FINE CHEM LIMITED, Mumbai. It was dissolved in double glass distilled water and administered intraperitoneally (i.p.) to mice. Lycopene was obtained from PASSIM Pharmaceuticals Limited, Baddi. It was dissolved in olive oil and administered intraperitoneally to mice. Thus olive oil is used as a vehicle to inject lycopene.

Experimental Design: The mice were divided into four groups of six mice each. **Group I** – Control animals were given distilled water. **Group II** – Animals were administered an acute dose of 0.32 mg/kg bw of cadmium (i.p.) for 15 days. **Group III** – Animals were kept as positive control and were injected (i.p.) 20 mg/kg bw of olive oil daily. **Group IV** – Animals were injected with an acute dose of 0.32 mg/kg bw of cadmium (i.p.) followed by a daily dose of 20 mg/kg bw of lycopene for 15 days. Autopsies were done on 15 days post treatment.

Blood sample collection: On the day of autopsy, blood was collected from each mouse under ether anesthesia. Blood was pooled in separate eppendrof tubes containing ethylenediaminetetraacid (EDTA) and centrifuged for 15 minutes. It was then used for testing various hematological parameters.

Hematological Parameters determination: The parameter such as packed cell volume (PCV), hemoglobin (Hb), white blood cells (WBC), neutrophils, lymphocytes, eosinophils, monocytes, red blood cells (RBC), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and mean corpuscular volume (MCV) were analyzed using automated analyzer.

Statistical analysis: The data was analyzed by using Student's *t*-test.

RESULTS AND DISSCUSSION

Cadmium, a toxic environmental pollutant has no known biological functions & when accumulated in the body from various sources, leads to various disease conditions.[10,11] Hounkpatin et al. [3] reported that the most important tissue in our body in which metabolic changes are reproduced is the blood. The alterations in the blood parameters are therefore considered to be one of the most reliable indicators of toxic effects of drugs, chemicals, heavy metals, etc.[12] The present decade has witnessed a great and intense resurgence in the interest and use of natural plants and natural plant products. It has also been suggested that lycopene can prevent carcinogenesis by protecting vital biomolecules including DNA, proteins, enzymes and lipids.[13]

In the present study, significant decrease was observed in hemoglobin (Hb), red blood cells (RBC), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV), packed cell volume (PCV) in cadmium treated group as compared to control (Fig.1 and 2).These changes are in confirmation with the findings of other workers.[14,15,16,17,18,19] Similarly, Lycopene administration showed increase in all the above said parameters as compared to the cadmium treated group (Fig 1 and 2).

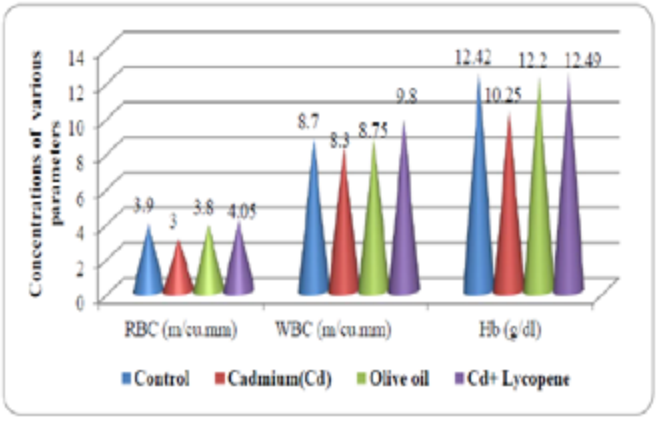

Fig. 1 Concentrations of RBC, WBC and Hb in all the groups.

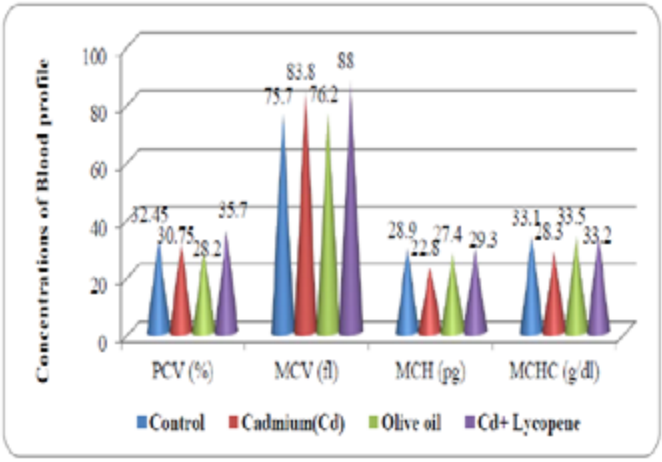

Fig. 2 Concentrations of PCV, MCV, MCH and MCHC in all the groups.

However, hematological parameters provide information about the status of bone marrow.[20] Further, the present study showed that hematological parameters in cadmium group treated mice depicted abnormalities. This might be because of excess glucose with the hemoglobin results in glycosylated hemoglobin with decrease in red blood cell (RBC) which further suggests an imbalance between haemoglobin synthesis and destruction and packed cell volume (PCV) are effected by cadmium-induced toxicity, causing anemia.[21,22] Lowered RBC count, decreased MCH and MCV are other hematological changes found in cadmium intoxicated group.[23] It is well known that the increased destruction of erythrocytes as evidenced from decreased red blood cell count & packed cell volume is due to oxidative damage to the erythrocytes, induced by cadmium, causing destruction of cell membrane by increasing lipid peroxidation.[5] Hounkpatin et al.[3] also suggested that this drop in haemoglobin (Hb) concentration can be attributed to the production of reactive oxygen species/ROS.

The most important of metabolic parameter for cadmium

uptake is a person's possible lack of iron. People with low iron supplies showed a 6 per cent higher uptake of cadmium than those with a balanced iron stock.[24] This is the main reason for the higher cadmium resorption in people with anemia and habitual iron deficit, such as children or menstruating women. Low iron blood levels stimulate the expression of DCT-1, a metal iron transporter in the GI tract, serving as a gate for cadmium resorption.[25]

Anemia is an important expression of cadmium toxicity.[26] Cd induced toxicity credited to damage in the synthesis of erythropoietin, a hormone whose role is to promote formation of red blood cells.[27] Friberg et al. [28] had noted that anemia in humans is because of environmental exposure to Cd. The liver, speen and bone marrow are the major hematopoietic organs which serve as targets of Cd exposure.[29] The present study has, however showed that Cd induced toxicity was ameliorated by lycopene administration. In addition, decrease in the MCV, MCHC and MCH as well as red blood cells while decrease in WBC and its indices (Neutrophils and Lymphocytes) in Cd treated group (Fig.3) might suggest decrease in immune system in fighting foreign substances. Eosinophils and monocytes remain unaffected in all the groups (Fig.3). The Blood concentration of cadmium serves as reliable indicator for a recent exposition, while the urinary concentration reflects past exposure, body burden and renal accumulation.[30]

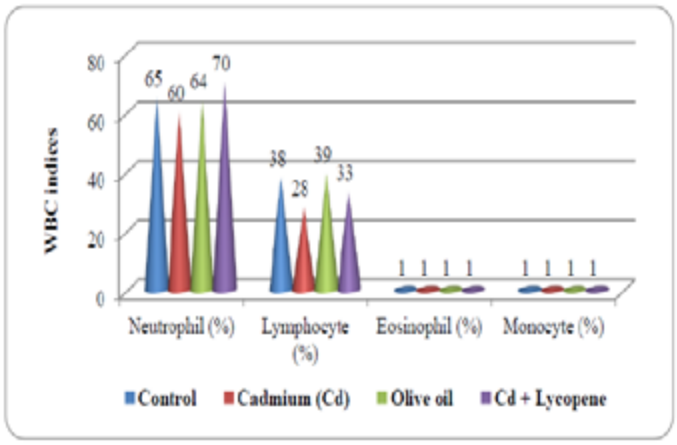

Fig. 3 WBC indices (%) in all the groups.

In lycopene treated group, all the parameters showed significant increase as compared to cadmium treated group. The results are in confirmation with the findings of other workers.[31,32] As, Lymphocytes are the main effector cells of the immune system. The increase in the lymphocyte count may be an indication of immunostimulation as observed in lycopene treated group.

Conclusion: Exposures to Cd depicted changes in the hematological profile of albino mice which accounts for the toxicity of cadmium. Lycopene which have antioxidant properties showed the ability to reverse the alterations in hematological parameters and thus ameliorated the toxic effects of cadmium. Thus it can be concluded from the results of the present study that lycopene showed marked protective effects against cadmium induced toxicity in mice.

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