Research Article

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# THERAPEUTIC EFFECTS OF OYSTER MUSHROOM IN CHROMIUM INDUCED TOXICITIES IN MICE

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## ABSTRACT

Chromium (Cr) content in poultry feed poses a potential risk of toxicity both for human and animal health. The research work was conducted to evaluate the adverse effect of Cr in adult male mice and ascertained the role of oyster mushroom in alleviating Cr toxic effects. A total of 40 mice (*Swiss Albino*), four weeks of age were used in the experiment. Mice treated with Cr showed a significant ($p<0.01$) decrease in value of total erythrocyte count (TEC), hemoglobin (Hb), packed cell volume (PCV) and total leukocyte count (TLC), whereas value of erythrocyte sedimentation rate (ESR) and mean corpuscular volume (MCV) were significantly increased ($p<0.01$) in relation to control. The values of TEC, Hb and PCV in mushroom treated groups were insignificantly differ but TLC values was slightly increased than healthy control. Administration of mushroom with Cr, values of TEC, Hb, PCV and TLC values were significantly increased($p<0.01$) and ESR values was significantly decreased ($p<0.01$) compared to Cr alone treated group. Total proteins decreased significantly, while alanine transaminase (ALT), aspartate transaminase (AST), alkaline phosphatase (ALP), urea, and creatinine increased significantly ($p< 0.01$) in Cr treated mice indicates the impairment of liver and kidney functions. Biochemical marker of liver profiles showed decreased in co-administration of mushroom along with Cr treated group. Moreover, creatinine and urea in the kidney also decreased while total protein increased significantly ($p<0.05$) in mushroom treated mice. Thus, Cr cause damage not only to hematological parameters but also causes adverse effects on liver and kidney in mice. Oral administration of oyster mushroom have therapeutic changes observed in all parameters, especially liver and kidney function test. Therefore, our finding concluded that oyster mushroom possess ameliorative effect against Cr induced toxicity in mice and may be useful in amelioration of metal toxicity in human and animals.

**Key words:** Cr, mushroom, toxicity, amelioration

## INTRODUCTION

The poultry industry in Bangladesh serves as a foundation of the nation economy, playing a pivotal role. However, an emerging concern within this thriving industry is the utilization of tannery waste, specially tanned skin cut wastes (SCWs), leather saving dusts (LSDs) as feed ingredients for poultry ration (Mottalib *et al.,* 2018 ). This practice, while aimed at cost reduction, introduces Cr content into the poultry feed, thereby posing potential risks of toxicity for human being. Chromium salts, notably Cr (III) sulfate, find extensive usage in leather tanning procedures, where they serve to stabilize collagen fibers, resulting in the production of soft and durable leather goods (Krishnamoorthy *et al.,* 2013). Consequently, the prevalence of Cr in the environmental is augmented, particularly through the accumulation of Cr-rich waste materials. Besides, Cr have profound implication across industrial applications, environmental contexts (Emsley, 2011). Heavy metal, Cr produce marked adverse health effects and poses significant risks to human and animal health upon exposure and being linked to cancer, mutagenesis, neurotoxicity, nephrotoxicity etc. (Gomez *et al.,*2006). Edible mushroom (*Pleurotus ostreatus*) for instance, serve as potent chelating agents, bolstering immune function,

exhibit antioxidant, antimicrobial and anticarcinogenic activities (Josh and Janardhanan, 2000; Wong *et al.,* 2020). A chelating agent, in heavy metal poisoning bind to toxic metal ions, facilitating their elimination from the body. Polysaccharides from mushrooms and herbs have been utilized as chelating agents as stated by (Aggarwal *et al.,* 2012). Also, numerous studies indicate that mushroom lectin effectively scavenges the superoxide anion, hydroxyl radical and stand out for their antioxidant (Oluwamodupe *et al.,* 2013) and immunomodulatory effects, which have been linked to improvements in growth, immunity, and intestinal health (Khan *et al.,* 2018). Against this backdrop, this current study endeavors toward exploration of the therapeutic capacity for oyster mushrooms in mitigating chromium-induced toxicity in mice. Through comprehensive assessments of hematological and biochemical parameters, the study seeks to shed light on oyster mushroom to ameliorate the Cr induced toxicities in mice.

## RESULT AND DISCUSSION

**Effects on body weight**

The physical parameter like body weight of all Swiss albino mice were presented in Fig-1. The highest body weight was observed in control group (44.8±1.07) and lowest in Cr treated group (37.4±0.51). Live body weight decreased significantly ($p < 0.01$) in Cr treated mice than control indicate more prominent toxicity as compared to control. The body weight in group C was very similar to that of control but group D were significantly higher ($p < 0.01$) than Cr alone treated group indicating the beneficial effect of mushroom against Cr toxicity.

Decreased body weight could be due to changes in liver glycogen and triglyceride along with a disturbance in metabolic enzymes leading to weight loss according to Jaen G *et al*., 2021(15). Previous study suggested that chromium has been reported to increase lean body mass and decrease percentage body fat, which may lead to weight loss in humans, Richard A, 1998 (30). Moreover, decreased body weight could be due to metabolic deregulations due to Cr toxic effects on the liver. Previous research (Mohammad *et al.,* 2014; Scibior *et al.,* 2006) reported that chromium toxicities leads to develops dull, depressed and significant reduction in body weight. Our study demonstrates significant relationship between decreases in live weight and heavy metal toxicity. Mushrooms have long been used not only as food but also for medicinal purpose in the treatment of various ailments. The protective effect of oyster mushroom against As and Cr toxicity is mainly due to its active constituent, alkaloids, phenols and flavonoids which function as antioxidants and as potential chelators. Our work demonstrated that oyster mushroom exhibit protective effects against Cr toxicity in mice.

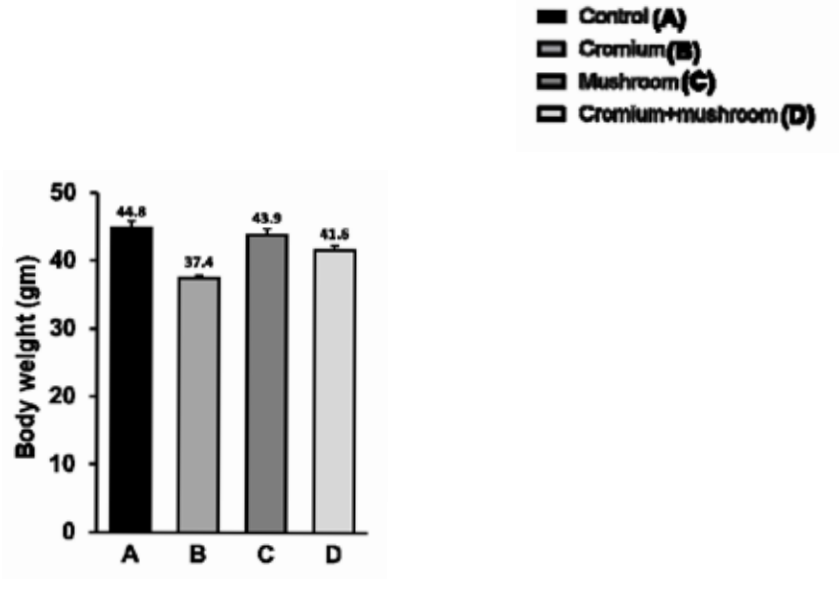


**Fig. 1:** Body weight of mice (gm). Values are represented as Mean ± SE.

**Effects on hematological parameters of mice**

Assessment of hematological parameters can be used to determine the extent of deleterious effect of Cr on blood components of an animal. The values of hematological parameters of all treated mice were presented in Fig.2. The total number of RBC (million/cumm), Hb (gm/dl), PCV (%) and TLC (thousand/cumm) were significantly ($p <0.01$) declined in Cr treated mice compared to the control. Conversely, ESR, MCV, MCH and MCHC values were significantly increased in Cr treated mice compared to the control. The values of TEC, Hb and PCV in

mushroom treated groups (8.86±0.14, 8.88±0.10 &33.8±0.80 respectively) were insignificantly differ from that of control but the TLC values (10.07±0.08) was slightly increased than control. ESR increased significantly in Cr given to mice compared to the control group as well as other treated groups in the current experiment. On the other hand, administration of mushroom with Cr, the values of TEC, Hb, PCV and TLC values were significantly ($p < 0.01$) increased and ESR values was significantly ($p < 0.01$) decreased compared to Cr alone treated group.

Earlier studies reported decreased hematological parameters because of Cr treatment in rats and broilers (Ray, 2016; Latha *et al,* 2018), respectively. A decrease in erythrocytes numbers, hemoglobin concentration, and hematocrit levels indicates an anemic condition, which could be a decrease in the availability of iron for hemoglobin synthesis a result of heavy metals exposure leading to the development of anemia (Ray, 2016). Another possible reason could be the ability of Cr to cross the red blood cell membrane where it forms DNA protein crosslinks leading to anemia. Anemia could also occur due to the binding of chromium to the β-chain of hemoglobin; thus, hemoglobin would not be available for heme synthesis ultimately anemia develops (Adjroud, 2010). Chromium taken up by erythrocytes undergoes reduction to the trivalent form with the help of reduced glutathione (Lopotych *et al.,* 2020), chromium-hemoglobin complexes, and other intracellular proteins are sufficiently stable to retain chromium for a substantial fraction of the RBC lifetime (Mashkoor *et al.,* 2013). The cytopathic effect of chromium is attributed to its interference with the erythrocytes' energy production pathway leading to interference in ATP production as well as also interferes with mitochondrial enzymes, so there could be no ATP production; ultimately cell lysis occurs leading to developed higher level of ESR.

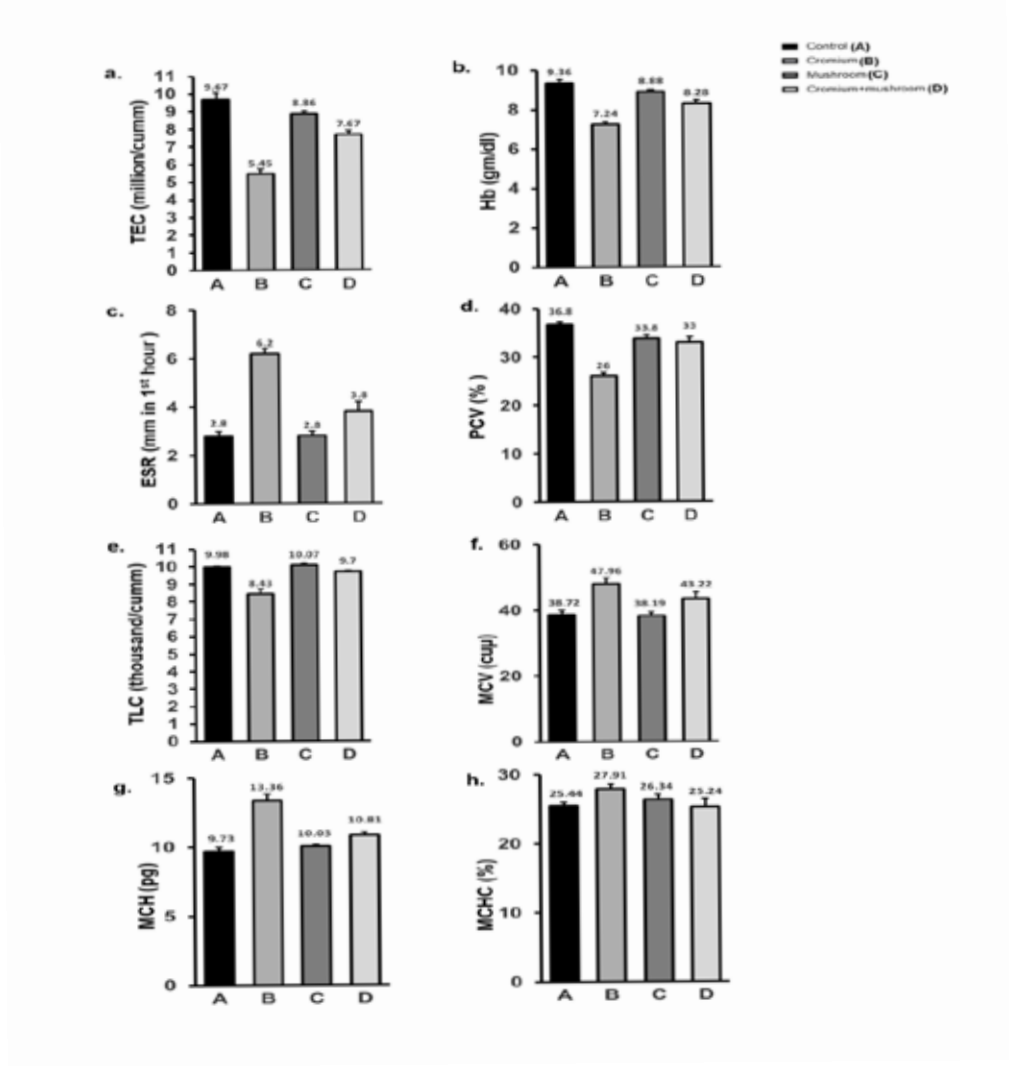


**Fig. 2:** Hematological parameters of mice (a) TEC (b) Hb (c) PCV (d) ESR(e) TLC (f) MCV (g) MCH (h) MCHC. Values are represented as Mean ± SE.

Significantly ($p < 0.05$) decreased leukocyte counts were recorded in Cr administered male mice compared to control in the present experiment. Earlier studies reported decreased leukocytes following chromium administration in rats. A decrease in leukocytes could be due to the inhibitory effect of heavy metals on the immune system leading to leukopenia (Cirovic *et al.,* 2022). Chromium affects the cortisol level and may be partially liable for its immunostimulatory effects (Kandpal *et al.,* 2019). Cortisol influences antibody production and the functions of lymphocytes and other leukocyte populations (Paustenbach *et al.,* 2003), thus leading to leukopenia. The results of our study show significant effect of *oyster mushroom* on hematological parameters in mice. In the study, the increase in TEC, hemoglobin level and PCV in the mushroom treated groups may be due to strong antioxidant effect of *oyster mushroom* which prevent the destruction of RBC's from free radical formation (Bodeker C *et al.,* 2005; Breene W, 2005; Ahmed and Aslam, 2018; Tanko *et al.,* 2012). Administration of mushroom in heavy metal treated mice marked decrease the oxidative stress marker and flavonoids in mushroom may act as free radicle breakers which can inhibit ROS generation leads to decreased ESR level (Ogbomida *et al.,* 2018). There is an increase level in the leukocyte count in mushroom treated groups and this effect is due to the presence of polysaccharides (Shi *et al.,* 2013). However, this increase in leukocyte count shows that this extract has an immunomodulatory effect which can boost up the immune system of rodents by increasing the production of WBC (John *et al.,* 2012; Ahmed and Aslam, 2018).

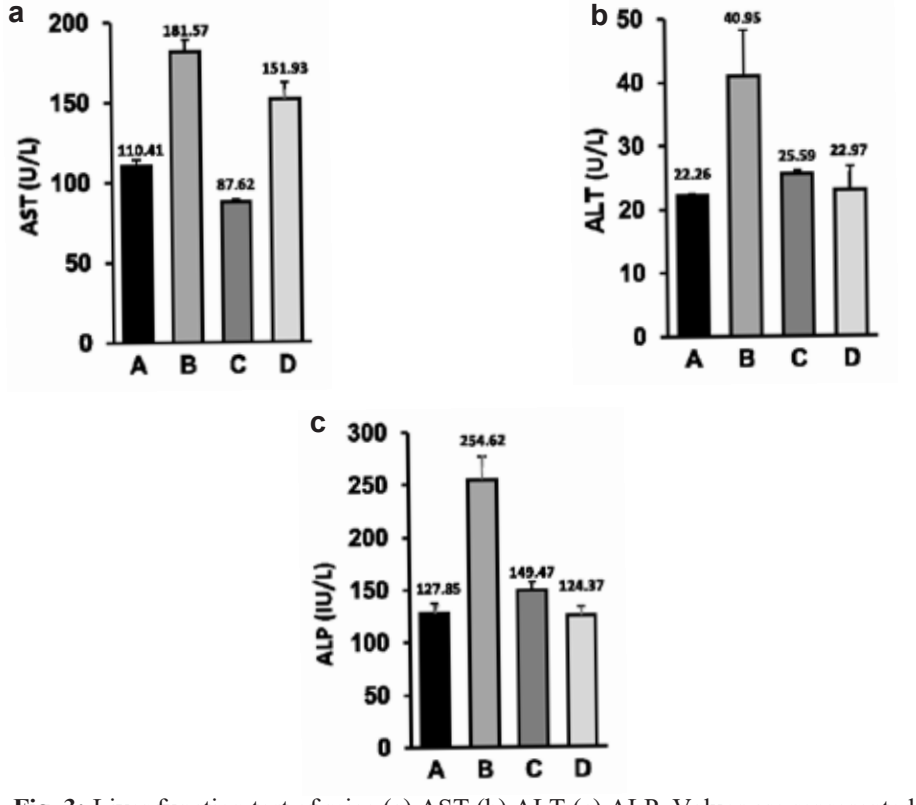


**Fig. 3:** Liver function test of mice (a) AST (b) ALT (c) ALP. Values are represented as Mean ± SE.

**Effects on Liver function**

Evaluation of enzyme activities in liver is significant in the investigation and diagnosis of liver injury. Levels of AST, ALT and ALP biomarker enzymes in the liver are widely used as biochemical parameters for analysis. In our study, serum AST, ALT and ALP levels were significantly increased after Cr induction as compared to the control group ($p<0.01$). indicates abnormalities in liver cells. In group C, treated with mushroom, the serum ALT and ALP concentration were similar but serum AST level were significantly decrease compared to control. In group D, the ALT and ALP values were similar to that of control and substantially lower in the B group ($p<0.01$). In addition, AST serum

concentration was significantly higher in group D compared to control but significantly lower than Cr treated group in Fig. 3.

Earlier studies reported increased ALT and AST concentrations in rat and fish (Saxena and Tripathi, 2007) intoxication with chromium. An increase in the level of ALT and AST could be due to leakage of these enzymes indicating damage to hepatocytes due to heavy metals. In addition, increased levels could be a result of the biotransformation of chromium in hepatocytes rendering injury to hepatocytes (Mashkoor *et al.,* 2023). Heavy metals are known to produce ROS in the body. Hepatocytes develop various defensive mechanisms to block ROS consequences leading to damage the hepatic cells and elevated the serum enzymes. In comparison with the normal control, mushroom treatment was able to restore AST, ALT and ALP to normal levels. The result therefore indicates that mushroom extract can ameliorate heavy metal toxicity significantly by their antioxidant as well as potential chelators activities.

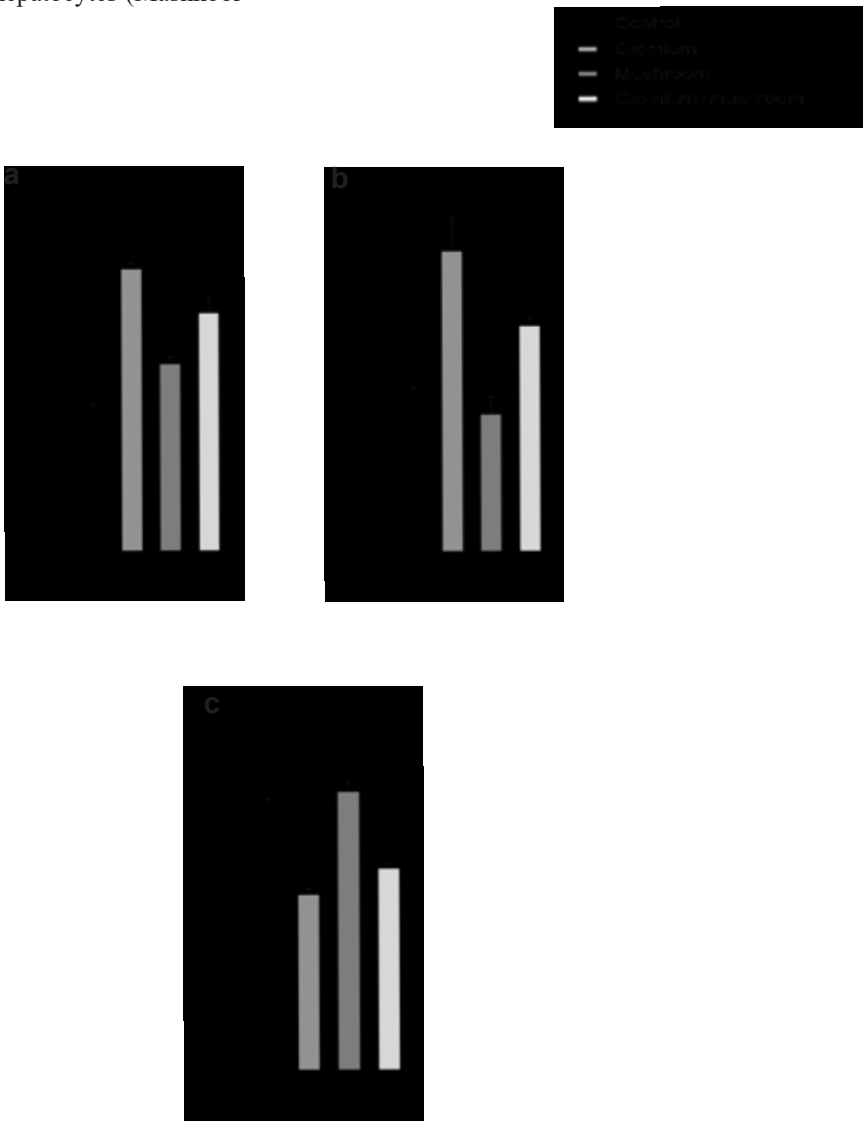


**Fig. 4:** Kidney function test of mice (a) Urea (b) Creatinine (c) Total Protein. Values are represented as Mean ± SE.

**Effects on Kidney function**

To evaluate the effect of Cr toxicity on kidney and the antitoxic effects of mushroom, blood was collected for analysis of biochemical parameters like total protein, serum urea and creatinine level. The values of total protein, urea and creatinine level in all treated groups were presented in Fig. 4. The values of total protein level in Cr treated group was significantly ($p<0.01$) lower than all other groups and the values was higher in mushroom treated group. In comparison with the control, mushroom treatment group was partially able to restore total protein level but significantly ($p<0.05$) increased compared to Cr treated group. A decrease in plasma proteins could also be due to the impairment of podocytes due to the production of reactive oxygen species (ROS) by heavy metal toxicity. ROS induces unrepairable damage to podocytes leading to changes in cell integrity, thus affecting the glomerular filtration

rate (GFR) and leakage of proteins (Mashkoor *et al.,* 2023). Serum urea and creatinine levels were significantly ($p<0.01$) higher in Cr treated group compared to control. The value of creatinine in mushroom treated group was significantly ($p<0.0001$) lower than all other groups but urea value was slightly higher than control. In group D, mushroom treated with Cr, the values were significantly ($p<0.05$) reduced compared to Cr treated group. Earlier reports showed a rise in urea and creatinine in rats (Ma *et al.,* 2022) for chromium toxicity. Urea and creatinine levels decreased could be due to ROS generation, which then causes lipid peroxidation. These lipid droplets sediment in the endothelium of glomeruli, thereby affecting GFR, ultimately damaging the membrane components and leading to necrosis, elevated urea and creatinine occur (Mashkoor *et al.,* 2023). Oral administration of *oyster mushroom* extract reduces the level of creatinine and urea as well as increase the protein level by its antioxidant capability. Previous study suggested that administration of mushroom progressively lowered creatinine levels (Ogbomda *et al.,* 2018).Thus, the research suggested that the oral consumption of edible oyster mushroom could in addition to its nutritive value, protect human and animal from the detrimental damage caused by heavy metal, Cr toxicity. The protective efficacy of edible mushroom powder may be due to the presence of several active components which may provoke the function of hematopoietic organ, liver and kidney by increasing the activity of free radical scavenging enzyme systems and renders protection against Cr induced effects. Therefore, eating mushroom may provide health benefits as well as help to reduce heavy metal toxicity risk.

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