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Effects of Sodium Dichromate on Haemato-biochemical Parameters in Wistar Rats

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ABSTRACT

A sub-acute toxicity experiment was conducted on 50 wistar rats which were randomly divided in five groups (group I to V) with five males and five females in each group to observe the haemato-biochemical alterations induced by sodium dichromate. Rats of group I to IV were administered graded dose of sodium dichromate @ 0.625, 1.25, 2.5, 5 mg kg^{-1}, respectively by oral gavage route for 28 days whereas, group V rats act as control. Highest dose of sodium dichromate reported to produce dullness, lethargy and diarrhea along with reduction in body weight and feed consumption. Significant decrease in hemoglobin, PCV, TEC, MCV and MCH values were observed while TLC values increased in group III and IV rats. Serum biochemical parameters viz AST, ALT, ALP and creatinine increased significantly while plasma total protein and albumin values were significantly decreased. In conclusion, hemato-biochemical picture reveals that dose rate up to 2.5 mg kg^{-1} of sodium dichromate was well tolerated and high dose (5 mg kg^{-1}) of sodium dichromate has potential to produce abnormalities in protein absorption and synthesis and kidney function.

Key words: Sodium dichromate, hematological, biochemical, wistar rats

INTRODUCTION

Chromium is a naturally occurring element found in rocks, animals, plants, soil, volcanic dust and gases. The most common forms found in nature are trivalent chromium and hexavalent chromium found in nature. Trivalent chromium is an essential nutrient required by the human body to promote the action of insulin in body tissues for utilization of sugar, protein and fat. In addition to this, chromium had reported to increase carcass yield in pig and broiler chicks (Acda and Chae, 2002; Toghyani *et al*., 2006; Anandhi *et al*., 2006). Whereas, hexavalent chromium generally produce by industrial processes. Sodium dichromate is one of the hexavalent salts of chromium and used as ingredient by tanning, dye, pharmaceuticals, photography, alloy, dry battery industries. Many reports are available regarding pharmacokinetics, carcinogenicity and its deleterious effects (Glaser *et al*., 1986; Saxena *et al*., 1990; Katnoria *et al*., 2008; Gohar and Mohammadi, 2010) but

very few researchers tried to correlate hematological and biochemical alterations by sodium dichromate at different dose levels in suitable animal model in rats.

MATERIALS AND METHODS

Rats were acclimatized for a period of one week before the initiation of sub-acute toxicity experimental exposure with sodium dichromate. Rats were housed in polypropylene cages provided with rice husk as the bedding material. Rats were kept under standard laboratory conditions as 25±5°C temperature, 45-55% relative humidity and 10 h light; 14 h darkness. The rats were fed standard pellet diet and deionized drinking water *ad libitum*. All the animals under experiment were observed daily for any abnormal physical or behavioural changes and mortality throughout the period. Body weight and left over the feed of groups 1 to 5 was taken initially on day 0 and then measured every week. The experimental protocol was approved by institutional animal ethic committee.

The sub-acute toxicity experiment was conducted on 50 wistar rats which were randomly divided in five groups (group I to V) with five males and five females in each group. Rats of group 1 to 4 were administered graded dose of sodium dichromate @ 0.625, 1.25, 2.5, 5 mg kg^{-1}, respectively by gavage route for 28 days whereas, only deionized water was given to rats of group V as control.

After completion of 28 days, the blood samples were collected from retro-orbital plexus of experimental rats for studying hematological (TEC, TLC, DLC, Hemoglobin, PCV, MCV, MCH, MCHC) and serum biochemical profile (AST, ALT, AKP, GGT, Total protein, Albumin, Globulin and Creatinine). Hematology parameters were analyzed by Auto Blood Analyzer (Merck Specialities Pvt. Ltd) and serum biochemical parameters were analyzed using Ecoline Kits (Merck Pvt. Ltd.,) by Auto Serum Analyzer (Selectra Junior, Merck Pvt. Ltd.). The collected data were analysed statistically as per Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

In the present study male and female rats of group I did not reveal any symptoms attributable to the 28 days administration of sodium dichromate. In group 2 and 3, animals did not reveal any symptoms except dullness in four rats of group 2 and three rats in group 3. Signs like dullness, lethargy and diarrhoea were observed in the rats of group 4 receiving high dose of sodium dichromate in last week of experimental period. No mortality was observed throughout experimental period. Similar observations were reported in humans (Zhang and Li, 1987) and rabbits (Tyl *et al*., 1991) following exposure to heaxavalent chromium. The possible reason for these could be corrosive and irritating effects of hexavelant sodium salt on gastrointestinal mucosa (Saryan and Reedy, 1988). Significant ($p<0.05$) dose dependant reduction in body weight in male and female rats at 28th day of experiment was observed in group 3 and 4 as compared with control group rats (Table 1). Moreover, significant decrease in mean values of feed consumption was observed in group 3 and 4 in comparison of control group (Table 2). Similar observation was recorded in rabbit on administration in hexavalent chromium (Tyl *et al*., 1991).

The details of various hematological and biochemical parameters studied have been presented in Table 3 and 4, respectively. In present experiment dose dependent significant decrease in hemoglobin and PCV values were reported in group 2, 3 and 4 as compared to control group. Similarly, significant decrease in mean values of TEC, MCV and MCH were experiential in high dose group 3 and 4 rats. For MCHC value, no significant difference was noticed in all groups

Table 1: Weekly body weight (Mean±S.E., g) in male (n = 5) and female (n = 5) rats of different experimental groups

	Days									
	0 day		7th day		14th day		21st day		28th day	
Group No.	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
I	274.8±2.00^{a}	239.2±3.97^{a}	296.2b±5.34^{a}	258.0±1.03^{ab}	318.2±4.04^{a}	276.4±5.00^{a}	335.4±6.68^{a}	296.6±6.29^{a}	357.4±5.46^{a}	325.8±6.46^{a}
2	270.0±2.74^{a}	239.2±3.12^{a}	286.0±6.18^{bc}	251.6±2.97^{ab}	304.8±5.79^{b}	267.2±6.11^{a}	325.0±6.12^{a}	288.0±6.04^{a}	341.0±6.78^{b}	304.8±5.75^{b}
3	270.6±1.96^{a}	239.4±7.12^{a}	272.6±2.27^{cd}	243.8±1.72^{c}	273.8±2.76^{c}	233.4±7.78^{b}	268.2±3.50^{b}	224.0±7.97^{b}	261.2±2.13^{c}	215.0±7.76^{c}
4	270.8±2.75^{a}	239.6±6.38^{a}	265.0±4.40^{d}	228.2±4.24^{d}	243.6±3.80^{d}	219.2±5.89^{b}	228.0±2.55^{c}	200.0±5.42^{c}	216.2±2.80^{d}	185.8±6.30^{d}
5	270.4±2.89^{a}	240.0±2.98^{a}	301.2±4.76^{a}	260.8±2.60^{a}	322.0±4.64^{a}	280.2±4.75^{a}	340.4±7.36^{a}	301.0±5.79^{a}	359.6±7.22^{a}	330.4±5.80^{a}

Superscripts are to be read column wise for mean comparison, Mean with similar superscripts in column do not differ significantly ($p<0.05$)

Table 2: Weekly feed consumption (Mean±S.E., g day^{-1}) in male (n = 5) and female (n = 5) rats of different experimental groups

	DAYS									
	0 day		7th day		14th day		21st day		28th day	
Group No.	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
I	20.4±0.24^{a}	17.6±0.25^{a}	21.6±0.24^{b}	19.6±0.40^{ab}	21.4±0..25^{b}	20.2±0.37^{a}	22.2±0.37^{a}	20.0±0.44^{a}	21.8±0.49^{b}	19.2±0.20^{b}
2	20.4±0.24^{a}	17.8±0.37^{a}	21.0±0.32^{b}	18.6±0.24^{b}	20.4±0.25^{c}	18.4±0.27^{b}	20.2±0.20^{b}	18.4±0.24^{b}	20.4±0.40^{c}	18.4±0.24^{b}
3	21.2±0.37^{a}	18.2±0.37^{a}	17.2±0.37^{c}	17.4±0.24^{c}	17.2±0.37^{d}	15.8±0.58^{c}	17.2±0.37^{c}	14.8±0.37^{c}	15.6±0.40^{d}	12.8±0.37^{c}
5	21.4±0.40^{a}	18.4±0.24^{a}	23.4±0.40^{a}	20.6±0.40^{a}	22.4±0.40^{a}	20.4±0.40^{a}	22.2±0.37^{a}	20.4±0.40^{a}	23.6±0.40^{a}	20.6±0.40^{a}

Superscripts are to be read column wise for mean comparison, Mean with similar superscripts in column do not differ significantly ($p<0.05$)

Table 3: Values of different hematological parameters (Mean±SE) in wistar rats of different experimental groups (n = 10)

Parametics	Group I (0.625 mg kg^{-1})	Group II (1.25 mg kg^{-1})	Group III (2.5 mg kg^{-1})	Group IV (5 mg kg^{-1})	Group V (Control)
Tec (X106 μL^{-1})	7.15±0.54^{ab}	7.07±0.23^{abc}	6.94±0.75^{bc}	6.9±0.11^{c}	7.20±0.65^{a}
Hb (g dL^{-1})	14.55±1.18^{a}	14.12±1.54^{b}	13.14±0.52^{c}	12.40±0.10^{d}	14.70±0.59^{a}
PCV(%)	43.05±0.21^{a}	41.80±0.28^{b}	39.02±0.39^{c}	36.29±0.24^{d}	43.53±0.13^{a}
MCV (fl)	60.19±1.63^{a}	59.13±0.15^{a}	56.31±0.90^{b}	52.72±0.88^{c}	60.43±0.11^{a}
MCH (pg)	20.33±1.52^{a}	19.97±0.20^{a}	18.96±0.30^{b}	18.01±0.30^{c}	20.41±0.90^{a}
MCHC (g dL^{-1})	33.77±3.26^{a}	33.76±2.76^{a}	33.91±0.12^{a}	34.07±0.18^{a}	33.78±1.63^{a}
TLC (X103 μL^{-1})	9.04±0.86^{c}	9.20±0.33^{b}	9.42±0.16	9.52±0.92^{a}	9.02±0.42^{c}
Differential leucocyte count (%)					
Neutrophils	19.90±0.23^{cd}	20.40±0.16^{c}	22.30±0.21^{b}	26.00±0.25^{a}	19.50±0.22^{d}
Lymphocytes	75.30±0.33^{a}	73.20±0.29^{b}	70.40±0.37^{c}	65.00±0.39^{d}	75.80±0.24^{a}
Monocytes	2.20±0.20^{b}	2.60±0.22^{ab}	2.80±0.20	2.70±0.15^{ab}	2.30±0.15^{ab}
Eosinophils	2.40±0.16^{d}	3.60±0.16^{c}	4.40±0.22^{b}	6.20±0.20^{a}	2.20±0.24^{d}
Basophils	0.20±0.13^{a}	0.20±0.13^{a}	0.10±0.00^{a}	0.10±0.00^{a}	0.20±0.13^{a}

Mean with similar superscripts in column do not differ significantly ($p<0.05$)

Table 4: Values of different serum biochemical parameters (Mean±SE) in wistar rats of different experimental groups (n = 10)

Parameters	Group I (0.625 mg kg^{-1})	Group II (1.25 mg kg^{-1})	Group III (2.5 mg kg^{-1})	Group IV (5 mg kg^{-1})	Group V (Control)
AST (IU L^{-1})	220.20±5.81^{b}	222.00±8.13^{b}	232.90±2.93^{ab}	250.60±9.32^{a}	210.50±9.26^{b}
ALT (IU L^{-1})	45.70±2.63^{ab}	42.60±2.83^{b}	43.60±2.78^{b}	52.00±1.18^{a}	42.60±2.98^{b}
AKP (IU L^{-1})	94.67±1.44^{ab}	96.49±2.13^{ab}	95.30±3.39^{ab}	101.50±1.79^{a}	93.08±2.71^{b}
GGT(IU L^{-1})	10.30±0.81^{a}	9.31±1.02^{a}	9.18±0.54^{a}	8.01±0.52^{a}	8.25±0.54^{a}
Creatinine (mg dL^{-1})	0.66±0.079^{b}	0.56±0.029^{bc}	0.84±0.013^{a}	0.82±0.048^{a}	0.48±0.052^{c}
Total Protein (g dL^{-1})	6.49±0.40^{a}	6.42±0.42^{a}	5.97±0.55^{ab}	4.60±0.72^{b}	6.51±0.53^{a}
Albumin (g dL^{-1})	2.47±0.33^{ab}	2.42±0.45^{ab}	2.39±0.35^{ab}	1.90±0.28^{b}	3.11±0.28^{a}
Globulin (g dL^{-1})	4.02±0.50^{a}	4.00±0.58^{a}	3.58±0.77^{a}	2.70±0.815^{a}	3.40±0.37^{a}

Mean with similar superscripts in column do not differ significantly ($p<0.05$)

compared with control group. Similar observation for MCV and MCH values were observed in rats on exposure of potassium dichromate (Agency for Toxic Substances and Disease Registry, 2000; NTP, 1996). Moreover, marked reduction in PCV, haemoglobin, RBC and protein values on prolonged exposure to cement dust (containing chromium and other heavy metals) in rats (Tajudeen *et al*., 2011). NTP (1997) also reported similar findings and suggested that an interaction between chromium and iron alters erythrocytes formation. The decrease in MCH, hemoglobin and PCV values could be attributed to the intracellular reduction of hexavalent chromium to trivalent chromium and subsequent binding of trivalent chromium to the various intracellular macromolecules and proteins including haemoglobin which interfering with iron assimilation in the red blood cells (Goyer, 1995). Leucocytes picture reveals, significant ($p<0.05$) increase in TLC along with neutrophilia, eosinophilia and lymphopenia in group 3 and 4. Similar findings were recorded in potassium dichromate ingested women (Sharma *et al*., 1978) and human due to chromium toxicity (Mancuso and Hueper, 1951).

In the present study, the highest dose of sodium dichromate i.e., 5 mg kg^{-1} caused significant increase in the value of AST, ALT and AKP in compared to control group. These findings are in accordance with observation in human (Kaufman *et al*., 1970) and rats (Acharya *et al*., 2001) for AST and ALT. No significant difference was observed for AST, ALT and AKP in group 1, 2, 3 compared to control group. Increased ALT and AST level may be due to soft tissue damage in the rats exposed to highest experimental dose of sodium dichromate. Moreover, experimental results showed dose rate upto 2.5 mg kg^{-1} was well tolerated by rats. For GGT level non-significant difference was observed between treatment groups and control group.

Mean creatinine value was significantly higher in groups 3 and 4 compared to control group. In support to present experiment finding Pedraza-Chaverri *et al*. (2005) and Fatima *et al*. (2005) observed nephrotoxicity on exposure of potassium dichromate in rats. Similar results were also observed in chrome plate workers (Verschoor *et al*., 1988) and rats (Fatima and Mahmood, 2007). Significant ($p<0.05$) reduction in total protein and albumin values was observed in the group 4 in compared to control group. Whereas, no significant difference was observed for globulin between different groups. Pedraza-Chaverri *et al*. (2005) and Glaser *et al*. (1990) observed similar results for total protein and albumin values in chromium exposure study in rats. Boscolo *et al*. (1997) also found no significant difference in serum globulin concentration on exposure of chromium in workers. Reduction in serum total protein and serum albumin induced by sodium dichromate treatment may be due to several factors like abnormalities in liver and kidney function and dietary protein deficiency as there was decrease in feed consumption in group 4.

In conclusion, hemato-biochemical picture reveals that dose rate up to 2.5 mg kg^{-1} of sodium dichromate was well tolerated by experimental rats. Moreover, this experimental result reveals high dose (5 mg kg^{-1}) of sodium dichromate has potential to produce abnormalities in protein absorption and synthesis and kidney function.

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