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Study of Cadmium and Chlorpyrifos Induced Changes in Protein and Lipid Profile in Rats

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Abstract

The present work was aimed to know the changes in protein and lipid profile induced cadmium and chlorpyrifos Wistar rats. Work was carried out for 28 days in rats. 1: Control. 2: $CdCl_2$ @ 22.5 mg/kg b.wt/oral. 3: CPF @ 25 mg/kg b.wt/per oral. 4: $CdCl_2$@22.5 mg + CPF @ 25 mg/kg b.wt/per oral. Results revealed a significant ($P<0.05$) decrease in the concentration of total protein and albumin in Groups 2, 3 and 4 and also a significant ($P<0.05$) increase in total cholesterol, triglycerides and phospholipids in Groups 2, 3 and 4 on 15th and 29th day of the experiment. The adverse changes in protein and lipid profile in combined Group were severe than individual Groups due to synergistic action of the combined pollutants.

Keywords: Cadmium, Chlorpyrifos, Lipid Profile, Protein Profile, Wistar Rats

1. Introduction

There are several heavy metals and pesticidal residues found in our environment and there is growing evidence that long-term exposure to heavy metals[1] and pesticides causes toxicity worldwide[2]. Cadmium (Cd) and Chlorpyrifos (CPF) are the most common toxicants among all toxic compounds in the environment. The Cd in agricultural soil comes from the application of phosphate fertilizers, sewage sludge and pesticides[3] and OP from insecticides and pesticides. Chlorpyrifos (CPF) is one of the most heavily used as pesticide in domestic and agricultural operations by the farmers[2]. Cd and CPF intoxication may occur directly through drinking water, indirectly through irrigation water source and through feed ingredients of plant origin. Since the animals tend to receive combination of multiple intoxicants through environment contamination, there is need for conducting induced toxicopathological studies to assess the impact of individual and combined environmental pollutants[4]. Cd induces oxidative stress and apoptosis[5]. The principal mechanism of toxicity of CPF is due to its inhibition of Acetylcholinesterase (AChE) and accumulation of Acetyl Choline (ACh) at the nerve endings and the neuromuscular junctions[6] thereby causing damage to various vital organs. Cd and CPF are known for damaging organs viz. liver, kidneys, brain, heart, lungs in humans and experimental animals[7] there by changing the protein concentration[8,9] and lipid levels[10,11]. The present work was aimed to study changes in lipid and protein profile induced by Cd, CPF and their combination in Wistar rats.

2. Materials and Methods

Prior approval Institutional Animal Ethical Committee was taken before starting of the experiment (IAEC No.

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I/2018-11/IAEC/CVSc, Hyderabad, Dated: 16-07-2018). Forty eight (48) adult male Wistar albino rats were procured from Sanzyme Laboratories Ltd., Hyderabad, animals were divided into four (4) Groups, twelve animals (12) in each Group. The rats were raised under controlled environmental conditions, fresh water, sterile feed to control Group; toxin mixed water and sterile feed to experimental Groups were provided at ad libitum regularly for four weeks. Rats were randomly divided into 4 Groups consisting of 12 in each Group. G-1 serves as control. G-2 rats were administered $Cdcl_2$ @ 22.5 mg/kg b.wt/per oral/day. G-3 rats were administered CPF @ 25 mg/kg b.wt/per oral/day. G-4 rats were administered $Cdcl_2$ @22.5 mg + CPF @ 25 mg/kg b.wt/per oral/day for 28 days of experiment. 2-3 ml of blood was collected on 15th day and 29th day from retro-orbital plexus of rats, with the help of a capillary tube into serum vaccutainers, serum was separated for estimation of biochemical parameters. Prior to blood collection, the selected experimental rats were put to fast for 12 hours. Serum was separated for estimation of albumin, Total Protein (TP), serum total cholesterol, triglycerides and phospholipids. Parameters were estimated in auto biochemical analyzer by using Erba kits by Transasia Bio-Medicals Ltd., Solan, Himachal Pradesh. Data obtained were subjected to statistical analysis by applying one way ANOVA using Statistical Package for Social Sciences (SPSS) version 16.0. Differences between means were tested by using Duncan's multiple comparison tests and significance level was set at $P<0.05$[12].

3. Results

3.1 Total Protein and Serum Albumin

Significantly ($P<0.05$) lower Total Protein (TP) mean values were noticed in Group 2 (6.86 ± 0.34 and 5.82 ± 0.41), Group 3 (8.54 ± 0.18 and 7.54 ± 0.27) and Group 4 (5.47 ± 0.33 and 3.68 ± 0.42) on 15th and 29th day of the experiment when compared with that of Group 1 (9.67 ± 0.21 and 10.92 ± 0.28). Significantly ($P<0.05$) lower mean values were noticed in Group 4 than in Groups 2 and 3. The mean values of albumin in Group 2 (2.96 ± 0.24 and 2.10 ± 0.27), Group 3 (3.11 ± 0.18 and 2.84 ± 0.23) and Group 4 (2.29 ± 0.14 and 1.75 ± 0.11) on 15th and 29th day of the experiment were significantly ($P<0.05$) lesser than the mean values of Group 1 (3.40 ± 0.15and 4.03 ± 0.16). Among the treatment Groups 2, 3 and 4, the mean values were significantly ($P<0.05$) lower in Group 4 on 15th and 29th day of the experiment Table 1.

Table 1. Serum albumin and total protein concentration (g/dL) in different Group s of rats

Group	Serum albumin		Serum total protein	
	Day 15	Day 29	Day 15	Day 29
G1	3.40 ± 0.15^a	4.03 ± 0.16^a	9.67 ± 0.21^a	10.92 ± 0.28^a
G2	2.96 ± 0.24^c	2.10 ± 0.27^c	6.86 ± 0.34^c	5.82 ± 0.41^c
G3	3.11 ± 0.18^b	2.84 ± 0.23^b	8.54 ± 0.18^b	7.54 ± 0.27^b
G4	2.29 ± 0.14^d	1.75 ± 0.11^d	5.47 ± 0.33^d	3.68 ± 0.42^d

Values are Mean ± Standard error (n = 6) One way ANOVA Mean + SE with different alphabets as superscripts differ significantly ($P<0.05$)

3.2 Serum Total Cholesterol, Triglycerides and Phospholipids

Significantly ($P<0.05$) higher mean values of serum total cholesterol were observed in Group 2 (57.99 ± 2.35 and 64.51 ± 3.25), Group 3 (47.94 ± 1.93 and 54.39 ± 1.88) and Group 4 (66.78 ± 1.43 and 72.73 ± 1.70) on 15th and 29th day of the experiment when compared with Group 1 (44.93 ± 1.35 and 49.52 ± 1.92). However, there was a significant ($P<0.05$) increase in mean values of combined toxic Group (Group 4) than the individual treated Groups. The mean values of serum triglycerides were significantly ($P<0.05$) high in Group 2 (51.02 ± 1.20 and 59.80 ± 1.26), Group 3 (41.79 ± 1.67 and 44.49 ± 2.37) and Group 4 (60.33 ± 1.52 and 68.03 ± 1.74) on 15th and 29th day of the experiment when compared to that of Group 1 (30.98 ± 1.30 and 31.98 ± 1.38). Significantly ($P<0.05$) higher mean values were noticed in Group 4 than in Groups 2 and 3. The serum phospholipids (mg/dL) values were significantly ($P<0.05$) high in Group 2 (65.11 ± 1.39 and 71.63 ± 1.48), Group 3 (55.06 ± 1.29 and 61.51 ± 1.25) and Group 4 (73.90 ± 1.56 and 79.85 ± 1.57) on 15th and 29th day respectively when compared to that of Group 1 (52.05 ± 1.71 and 56.64 ± 1.43). However, significantly ($P<0.05$) higher mean values were noticed in Group 4 than in Groups 2 and 3 Table 2.

Table 2. Serum total cholesterol, triglycerides and phospholipids concentration (mg/dL) in different Groups of rats

Group	Serum total cholesterol		Serum triglycerides		Serum phospholipids	
	Day 15	Day 29	Day 15	Day 29	Day 15	Day 29
G1	44.93 ± 1.35^{d}	49.52 ± 1.92^{d}	30.98 ± 1.30^{d}	31.98 ± 1.38^{d}	52.05 ± 1.71^{c}	56.64 ± 1.43^{d}
G2	57.99 ± 2.35^{b}	64.51 ± 3.25^{b}	51.02 ± 1.20^{b}	59.80 ± 1.26^{b}	65.11 ± 1.39^{b}	71.63 ± 1.48^{b}
G3	47.94 ± 1.93^{c}	54.39 ± 1.88^{c}	41.79 ± 1.67^{c}	44.49 ± 2.37^{c}	55.06 ± 1.29^{c}	61.51 ± 1.25^{c}
G4	66.78 ± 1.43^{a}	72.73 ± 1.70^{a}	60.33 ± 1.52^{a}	68.03 ± 1.74^{a}	73.90 ± 1.56^{a}	79.85 ± 1.57^{a}

Values are Mean ± Standard error (n=6) One way ANOVA
Mean + SE with different alphabets as superscripts differ significantly (P<0.05)

4. Discussion

Biochemical parameters revealed a significant (P<0.05) decrease in the concentration of total protein and albumin in Groups 2, 3 and 4 on 15th and 29th day of the experiment. It was noticed that an increased activity of transaminases in cadmium treated rats indicated liver dysfunction, which was accompanied by elevated levels of these hepatic marker enzymes and decrease in the concentration of albumin and total proteins suggestive of cellular leakage and loss of functional integrity of cell membrane in liver due to hepatocellular necrosis. Decline in total proteins and albumin also might be due to decrease in feed consumption, cadmium-induced hepatic and renal necrosis resulting in loss of proteins. Similar findings were reported by earlier reporters in Cd treated rats[13,14] and in CPF treated rats[15,16]. Co-administration of both the toxicants produced further increase in these enzyme levels as compared to individual administration of either toxicant. A significant (P<0.05) increase in total cholesterol, triglycerides and phospholipids was observed in all the treatment Group s and these values were more in combined Group than individually treated Groups on 15th and 29th day of the experiment. Increased concentrations of total cholesterol, phospholipids and triglycerides in serum serve as an index for hepatopathy and renal failure by Cd, CPF due to induction of lipid peroxidation. Similar findings were recorded in Cd[10] and in CPF treated rats[11].

5. Conclusion

It is concluded that the changes in lipid and protein profile in combined $CdCl_2$ and CPF Group (Group 4) were more severe than the individual Groups (Groups 2 and 3) due to synergistic action of the both pollutants.

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7. References

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