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Effects of Metal Poisoning on Total Body Protein in Common House Rat (*Masrattus rattus*)

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Many metals are required for normal physiological functions of human in very low concentrations. However, altered physiological functions result when one or more of these reach sufficiently high concentrations in body cells. In the present investigation the effect of three metal compounds, *viz*., copper sulphate, cobalt nitrate and Mohr's salt on the total body protein of a terrestrial mammal *Masrattus rattus* has been studied. It was observed that both the male and the female mice showed decline in the total body protein concentration on the treatment with all these three metal compounds. The decline became increasingly significant with the increase in the concentrations, being most dramatic in the case of copper sulphate. It is assumed that metal ions in high concentrations act as inhibitors to different enzyme systems responsible for protein synthesis.

Key Words: *Masrattus rattus*, Total body protein, Metal poisoning.

INTRODUCTION

Many metals are required for normal physiological functions of human, especially for women, in very low concentrations. Almost, all the health tonic referred by physicians contain the metal ions like iron as iron gluconate, cobalt as cyano cobalmine and copper as copper foliate affecting the growth and the productivity of the terrestrial ecosystem. Many metals are required for normal physiological function of mammals, but only in very low concentrations. These include copper, iron, zinc, manganese, cobalt, selenium and chromium[1]. It is assumed that most of these may have similar functions in fish and other mammalian.

However, altered physiological functions result when one or more of these reach sufficiently high concentrations in body cells both in aquatic animals and mammals. Metals other in the aquatic environment by a variety of industrial effluents and old mines. Acid precipitation also causes leaching of metals from surrounding soil[2].

Copper and iron proteins participate in many of the biological reaction *viz.*, (i) Reversible binding of dioxygen, *e.g*., hemocyanin (Cu), hemerythrin (Fe) and hemoglobin (Fe). (ii) Activation of dioxygen *e.g*., dopamine hydroxylase (Cu), tyrsinases (Cu) and catchol dioxygenases (Fe). (iii) Electron transfer, *e.g.*,

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plastocyanins (Cu), ferredoxins and cytochromes. (iv) Dismutation of superoxide by Cu or Fe as the redox-active metals.

The study of physiological changes as means for understanding the responses of terrestrial animals, like rabbets, rats, *etc*., to the stress of various types of pollution is of great help in studying the nature and the extent of pollution. Eister *et al*.[3] prepared bibliographies on the biological effects of metals in terrestrial environment.

Thus, usually the presence of transition metals like Fe, Cu, Co, Ni and Zn are highly essential for the growth of body and proper regulation of physiological metabolic activities of body especially for women during the period of her pregnancy. However, the gradual increase in this concentration may lead to the poisoning effect. The present investigation is an attempt of study the effects of three metal compounds, *viz*., copper sulphate, cobalt nitrate and Mohr's salt on the total body protein of a terrestrial rats, *Masrattus rattus*. From the morphogenic point of view, investigation of body proteins and amino acids are of particular interest because they provide an adequate background to judge the synthetic activity associated with the differentiation process in organisms.

EXPERIMENTAL

The mammals (*Masrattus rattus*) were treated separately in different batches by the following metal compounds in different concentrations.

Copper sulphate: The LC_{50} of the compound on the rats was worked out to be 1 M concentration and as such ten different concentrations of the compound were taken from 0.1-1 M. In each concentration of the solution, 3-50 rats were kept and biochemical assays were performed after 24 h of each treatment.

Cobalt nitrate: The LC_{50} for he rats in this case was found to be 0.055 M and 30-50 rats were placed in nine different concentrations ranging from 0.047-0.055 M and the biochemical assays were performed in each case after 24 h of treatment.

Mohr's salt: The LC_{50} of Mohr's salt for the rats was found to be 0.1 M. Hence, ten different concentrations of the compound ranging from 0.01-0.1 M were taken and in each 30-50 rats were placed for 24 h for biochemical assays.

Quantitative estimation of total body protein of treated and control (untreated) rats was done by Lowry's method[4] using Erma colorimeter.

RESULTS AND DISCUSSION

Total body protein concentration of 'control' rats: The control (untreated) adult male rat was found to have a total body protein concentration of 230 ± 6SD g/g of body weight. The control (untreated) adult female rate had a little higher protein concentration *i.e*., 272 ± 6SD g/g of the body weight.

Total body protein concentration of the 'treated' rats

Treatment with copper sulphate: Both the male and the female rats showed considerable ($p < 0.05$) decline in the total body protein concentration in the first treatment itself, *i.e*., in 0.1 M concentration of the compound. The decline became

increasingly significant with the increase in the concentrations of the compound in both the sexes and became significant ($p < 0.001$) from 0.6 M concentration onwards (Table-1).

TABLE-1
BODY PROTEIN CONCENTRATIONS IN RAT
ON TREATMENT WITH COPPER SULPHATE

Concentration of copper sulphate (molar)	Body protein concentration (g/g body weight ± SD)	
	Male	Female
0.1	180 ± 2	210 ± 4
0.2	175 ± 3	190 ± 7
0.3	150 ± 5	160 ± 8
0.4	135 ± 4	145 ± 6
0.5	110 ± 2	114 ± 3
0.6	100 ± 3	100 ± 3
0.7	100 ± 2	100 ± 5
0.8	85 ± 3	92 ± 4
0.9	70 ± 2	82 ± 3
1.0**	55 ± 3	25 ± 3

* Mean wt. of insect: male rat: 250 g ± 9SD, female rat: 265 g ± 10 SD, **LC_{50}, body protein in 'control', male rate: 240 g ± 6 SD, female rat: 262 g ± 6 SD.

Treatment with cobalt nitrate: In cobalt nitrate treatment a gradual decline in the total body protein concentration was noted from the lowest concentration (0.047 M) to the highest (0.55 M). Here also the decline in protein concentration was significant ($p < 0.05$) in both the sexes right from the treatment in lowest concentration (0.047 M) and became increasingly significant in the increasing concentrations of the compound, becoming most significant ($p < 0.01$) in the maximum concentration treatment (0.055 M). However, the decline was not as dramatic as in the case of copper sulphate (Table-2).

TABLE-2
BODY PROTEIN CONCENTRATIONS IN RAT
ON TREATMENT WITH COBALT NITRATE

Concentration of cobalt nitrate (molar)	Body protein concentration (g/g body weight ± SD)	
	Male	Female
0.047	200 ± 7	210 ± 8
0.048	185 ± 3	200 ± 3
0.049	170 ± 4	165 ± 6
0.050	145 ± 8	150 ± 7
0.051	140 ± 2	140 ± 2
0.052	130 ± 5	132 ± 7
0.053	120 ± 3	125 ± 6
0.054	110 ± 4	110 ± 7
0.055**	90 ± 6	95 ± 4

*: Mean wt. of insect: Male rat: 255 g ± 9S D, female rat: 265 g ± 10 SD, **LC_{50}, body protein in 'control', male rate: 230 g ± 6 SD, Female rat: 272 g ± 6 SD.

Treatment with Mohr's salt: An insignificant ($p > 0.05$) decline in the total body protein concentration of male rat was noted when they were exposed to 0.01 M concentration of salt, but 0.2 M onwards the decline in the concentration became significant ($p < 0.05$). The decline was found to be highly significant ($p < 0.001$) from 0.08-0.1 M concentration (Table-3).

TABLE-3
BODY PROTEIN CONCENTRATIONS IN RAT ON TREATMENT WITH MOHR'S SALT

Concentration of Mohr's salt (molar)	Body protein concentration (g/g body weight ± SD)	
	Male	Female
0.01	220 ± 3	240 ± 4
0.02	200 ± 4	230 ± 3
0.03	180 ± 3	210 ± 5
0.04	170 ± 4	205 ± 2
0.05	160 ± 2	200 ± 3
0.06	140 ± 5	170 ± 4
0.07	135 ± 2	140 ± 3
0.08	120 ± 4	140 ± 2
0.09	110 ± 2	120 ± 3
0.1**	90 ± 3	100 ± 4

*Mean wt. of insect: male rat: 250 g ± 9SD, female rat: 265 g ± 10 SD, **LC_{50}, body protein in 'control', male rate: 230 g ± 6 SD, female rat: 272 g ± 6 SD.

The results clearly indicate that all the three metal compounds adversely affect the protein synthesizing machinery of the rat, the effect increasing gradually from lower to higher concentrations. This is in accordance with the findings of the earlier workers on other rates[5-7].

On treatment with Mohr's salt and cobalt nitrate, the female rats generally showed a higher body protein concentration than that of male rat. However, in the case of copper sulphate treatment this trend was suddenly reversed in the maximum concentration (1 M). This may be due to the fact that the protein synthesizing machinery of the rat is so much affected in this case that it can not synthesize yolk protein for egg maturation.

Body protein, carbohydrate and ascorbic acid syntheses are under enzymatic control. Some of the metal ions are known to act as inhibitors to different enzyme systems. In the present investigation it is assumed also that copper, cobalt and iron in the more required concentrations act as inhibitors to various enzyme systems involved in the synthesis of protein.

Since the treatment with copper sulphate showed a greater decline in the concentration of protein as compared to those with cobalt nitrate and Mohr's salt, it is inferred that copper has a more potent role on enzyme system than the other two metals.

It may thus be concluded that all the three metal compounds pollute the terrestrial environment and even in low concentrations affect the physiology of the rat inhibiting

the synthesis of essential biochemical components like protein, thus affecting the production and growth of the rat. As the rat is an important constituent of the ecosystem in maintaining a normal functional life at land, *etc*., the decline in the growth and production of the rat would ultimately affect the normal life at land. Moreover, similar adverse effect on the physiology of fishes and other Mammalians is also expected under the influence of these chemicals.

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