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Research Article

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Effect of Cadmium and Lead Exposure in Albino Rat

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Abstract To determine the metal accumulation in vital tissues *i.e.* liver and kidney, albino rats were exposed to sublethal doses ($1/10^{th}$ of LD_{50}) each of cadmium (Cd) and lead (Pb) individually and in combination for a period of two months. Administration of both cadmium and lead exposure simultaneously depressed weight gain more, than in the rats exposed by either metal. Change in color of fur was observed in cadmium and combined exposure groups only. Accumulation of both the metals i.e. leads and cadmium in liver and kidney was measured by atomic absorption spectrophotometer (AAS). Accumulation of cadmium was enhanced, while that of lead was decreased both in liver and kidney, during the combined exposure of toxicants (Pb and Cd), in comparison to their alone exposure. Relatively higher accumulation of both metals was observed in kidney than in liver.

Keywords Albino rats, Cadmium, Lead, Liver, Kidney

1. Introduction

Introduction of persistent toxic substances and heavy metals into environment is a major worldwide environmental issue. These substances are characterized by their longevity, thereby exerting high chronic toxicity. Among heavy metals lead and cadmium exposures have allured the circumspection of toxicologist and environmentalists, because of health problems associated with these metals. Both heavy metals are common source of contamination and are ubiquitous in the environment. Exposure of children to lead and cadmium from a mining area of Brazil was studied by Paoliello et al., 2002 [1]. Being cumulative poisons, they produced significant pathological changes in various tissues/organs in long-term exposures. Association of low blood lead concentration with infertility in women was observed by Chang et al., 2006 [2]. Lead is capable of inducing oxidative damage to brain, heart, kidneys and reproductive organs [3]. Cadmium (Cd) is an environmental pollutant that has serious toxicity in humans and animals and causes Itai-Itai disease [4]. The accumulation of Cd is consistently increased when a certain amount is ingested continuously [5]. Cd has an extremely long half-life (20-30 Years) in the human body [6] and is highly cumulative, especially in the liver and kidney [7-9]. The kidney is considered as the critical organ in long term low level exposure to Cd [10].

2. Material and Methods

For the present study, male Wister rats weighing 140-150 g were acclimatized for two weeks and then distributed at random in three experimental groups and a control group with six animals in each group. Rats were exposed to 8.8 mg/kg body wt. cadmium as cadmium chloride, 20 mg/Kg body wt. lead as lead acetate individually and in combination for a period of two months. Exposure of metal toxicants was given in drinking water. The animals were maintained under standard laboratory conditions (temperature 25±1 ºC) and relative humidity 50-60 %) and fed on commercial pellet diet obtained from M/S Lipton India Pvt. Ltd. Bangalore, and tap water *ad libitum*. Animals were under continuous observations during the period of exposure. Body weight was recorded initially at the start and finally at the end of each exposure periods.

2.1. Heavy metal accumulation in tissues

One gm of each liver and kidney tissue from control and exposed groups were digested in tri acid mixture in the ratio of 2:1:0.5 nitric acid, sulphuric acid and perchloric acid respectively. The contents were diluted up to the desired volume with the help of distilled water and estimation of cadmium and lead concentrations was performed with hollow cathode lamps at wavelengths 228.8 and 283.3nm respectively with a slit of 1.3nm by using atomic absorption spectrophotometer (Hitachi Z-6100).

2.2. Statistical Analysis

All the experimental results were expressed as mean ± standard deviation. Student's t-test was used to calculate the level of significance. Values of $p<0.05$ were considered significant.

3. Results and discussion

3.1 Body weight gain

Animals exposed to cadmium and lead individually were observed to have aggressive behavior during the exposure period. Colour of fur became yellowish in cadmium and combined exposure. This might be due to the accumulation of cadmium in the fur. Much variation was found in body weight gain in rats exposed to different toxicants as shown in figure 1.

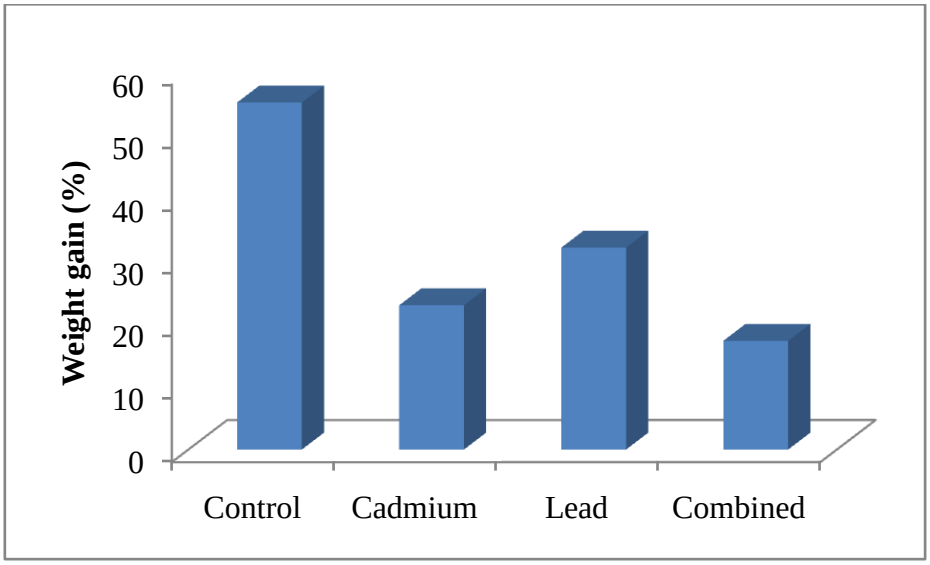

Figure 1: Body weight gain in exposed rats

The rats intoxicated with cadmium and lead showed marked decreased in body weight gain in comparison to the control group. Minimum gain in body weight of rats was observed in combined exposure group, which may be due to the additive effect of toxicants. In individual exposures cadmium was found more toxic in comparison to lead as shown by percent weight gain data. The reduction in body weight gain is also reported by many studies following lead and/or cadmium exposure to albino rat [11-13]. Significant dose dependent reduction in body weight gain after inhalative or oral cadmium uptake in rats were observed by Prigge (1978) [14]. Erdogan et al.(2005)[15] also reported decrease in body weight gain after cadmium exposure. Similarly, (Chowdhury et al., 1986) [16] supported that increasing dose of lead produced a gradual decrease in body weight gain in animals.

3.2 Metal accumulation in liver and kidney

Significantly higher levels of metal (cadmium and lead) content were found in both liver and kidney. Cadmium accumulation was found 141.20 times in the liver of rats exposed to cadmium alone in comparison to the control group (figure 2).

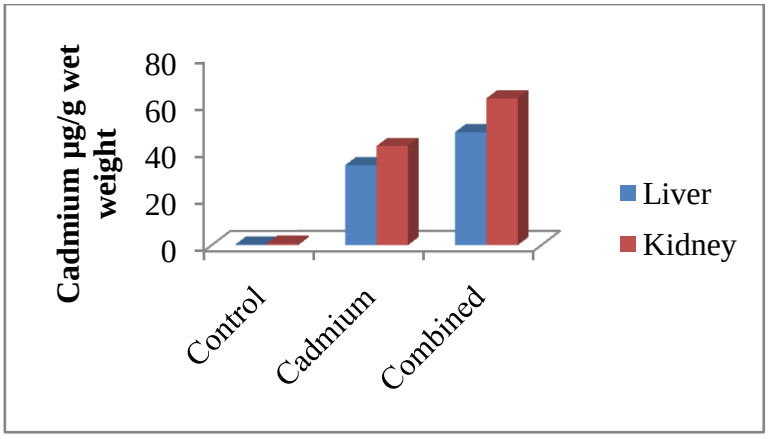

Figure 2: Accumulation of cadmium in rat tissues

Significantly higher amount of accumulation of cadmium was estimated in kidney also. The high levels of Cd accumulation in both liver and kidney over time might be due to involvement of these organs in the detoxification and moreover being the major organs of metabolic activities [17]. In the present study cadmium accumulated in higher amount in kidney than in liver both in cadmium alone and combined exposure. The kidney is considered as the critical organ in long term low level exposure to Cd [10]. Several authors reported that the organ of higher accumulation of Cd is kidney and also it is a detoxifying organ [4, 19-20,]. Similar findings were also observed by Usha Rani et al., (2010) [18]. Accumulation of cadmium in liver was found enhanced in combined exposure, when compared to the cadmium alone exposure. Cadmium accumulation was 199.45 times higher in combined exposure group, than the control rats. The metal accumulation in kidney was also increased from 67.77 times in cadmium alone exposure to 100.37 times in combined exposure. The results are in aggrement with Anilkumar et al., (2013) [21], which concludes that coexistence of both lead and cadmium showed a positive pharmacodynamics interaction.

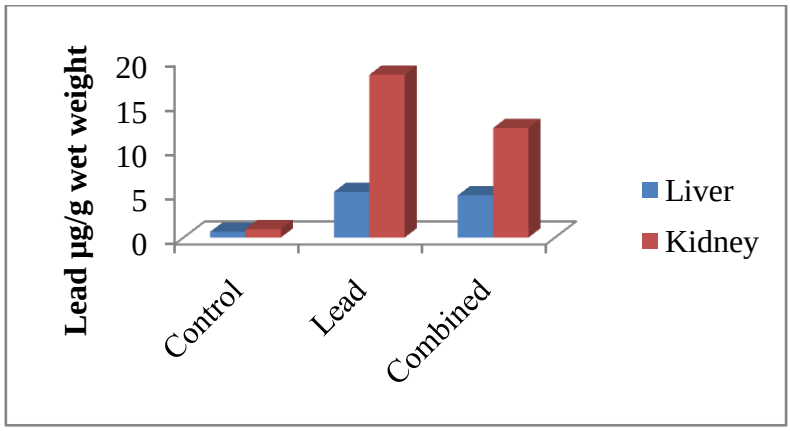

Figure 3: Accumulation of Lead in rat tissues

Estimation of lead content in liver showed that accumulation of lead was lower than cadmium in liver. Similar findings were observed by Josthna et al., (2012) [11]. In lead alone exposure the metal accumulation was 8.0 times higher to control group rats, while it was 7.39 times higher in combined exposure group (figure 3). Kidney accumulated lead in higher amount than liver. 19.21 times higher lead accumulation was recorded in lead alone exposure in comparison to control. Lead accumulation of 12.92 times that of control group was recorded in combined exposure. In the present study lead concentration was less in both liver and kidney in combined exposure, than in alone exposure and also as compared to cadmium concentration in the same. Approximately 90% of absorbed lead is reported to be stored in the bone with a half life of 600 - 3000 days. The remaining 10% is stored in soft tissues like kidney, liver and brain. The half life of lead in these tissues ranges from 40 - 50 days [22]. Kidneys play a major role in the excretion of lead from the body [23] and higher content of lead has been estimated in renal tissue than in liver and brain of the lead intoxicated animals in various studies [24], whereas,

cadmium is bound to metallothionein (a cadmium induced protein that protect the cell by tightly binding the toxic cadmium ion) in liver and kidney. Further, there is no efficient excretory mechanism for cadmium from the body and the most toxicological property of cadmium is its exceptionally long half life and thus its low excretion rate [25].

4. Conclusions

The present study results are in agreement with the various studies as discussed and revealed the additive effects of both the toxicants as shown by depression in weight gain data and accumulation of metals in liver and kidney. There was higher accumulation of cadmium in kidney than in liver, both in cadmium exposure alone and combined exposure. Similarly the concentration of lead was found higher in kidney as compared to liver, but cadmium is found more accumulative in nature in comparison to lead.

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