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EFFECT OF CADMIUM ON GROWTH IN WHITE RATS

By

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INTRODUCTION

Cadmium is considered as a modern toxic metal and important advanced industry as galvanizing or cathode material for nickel - cadmium batteries and others.

Its effect on body weight was observed by some authers, but their results were contradicted as Schroeder et al. (1963) and Kunimoto and Miura (1986) recorded either unsignificant or a decrease in body weight gain. On the other hand Sauter et al. (1976), Sugawara and Sugawara (1976), Merali and Singhal (1977), Piscator et al. (1981), Sastry and Subhadra (1985) noted significant or nosignificant increase in weight gain in different species of animals.

Cadmium toxicity affects calcium metabolism and consequently phosphorous leading to skeletal changes Nomiyama (1980). A decrease in renal phosphorus reabsorption and increased calcium urinary loss were discussed by Nogawa et al. (1975), Scott et al. (1976), Sakurai et al. (1980), Ng et al. (1980), Nishiyama and Nakamura (1984), Watanabe et al. (1986) and Kim et al. (1988).

The above reports draw the attention to correlate the body weight gain as well as bone development and its associated calcium and phosphorus levels in regard to cadmium consumption.

MATERIAL AND METHODS

A total of 80 apparently healthy albino rats ranged from 130-150 gm. of both sexes were kept under hygenic condition, offered a balanced ration and water ad-libitum for a period of 15 days for acclamatization these animals were divided into 4 equal groups. The first 20 rats were kept as control and the others 3 groups 1, 2 and 3 were dosed orally through a stomach tube by 0.143 mg, 0.561 mg and 2.00 mg cadium chloride/kg.B.Wt. respectively for 8 successive weeks. The first dose represent the highest mean of cadmium in water recorded in Egypt (About Salem 1991), while the second dose equivalent to $^1/_{10}$ the LD_{50} (Tanaka et al. 1983) and the third dose represent the effective dose

according to kim et al. (1988).

Animals were kept in metabolic cages, weighing and collection of urine samples to evaluate the growth rate were performed weekly.

At the end of the experimentation period, animals were sacrificed, blood collected, serum separated and the femur bone were isolated from musculature and their biometrical changes, diameter, thickness, length and the thickness at the diaphesis were recorded.

The calcium and phosphorous in serum, urine and bone were determined according to Gindler and King (1972) and Zilversmit and Dais (1950) respectively.

RESULTS

The effect of different doses of cadmium on body weight is tabulated in table (1). It was noticed that there is a decrease in body weight in comparison to the control group and in a dose dependent manner. The mean growth rate was 37.9%, 36.3% and 20.3% in the respective dose group in compareson to the 45.6% of the control group (Fig. 1).

The effect of cadmium on some biometrical parameters of femur bone and their calcium and phosphorus levels are tabulated in table (2) it was found that the length, thickness and thickness of diaphesis decrease in a dose dependant manner while the diameter showed a decrease in the third group only. Calcium content of bone showed a decrease in the three dosed levels while phosphorous revealed such effect in groups 2 and 3.

Table (3) illustrated the effect of cadmium on serum and urine calcium and phosphorus levels. Serum calcium concentration decreased in the three dosed groups in respect to the control gorup. In contrast to its levels in urine which revealed an

Table (1) : Effect of different doses of cadmium on the body weight (gm) of rats at different concentrations during the experimental period (8 weeks). (Mean ± S.E.)

Treatment	Weeks post-treatment				
	Zero	2nd W	4rd W	6th W	8th W
Control	150.8±1.79	168.56±4.2	182.9±3.07	192.2±2.52	219.5±4.81
143 mg/kg B.Wt.	151.57±1.17	174.7±2.55	178.0±1.64	187.3±1.09	209.16±3.20
0.56 mg/kg	153.00±2.55	172.83±1.82	177.6±2.25	185.83±2.00	208.60±3.41
2.00 mg/kg B.Wt.	150.5±1.82	156.0±1.82 **	161.6±1.21 **	172.0±2.24 **	181.00±3.19 **

Table (2) : Effect of cadmium on some parameters of femur bone (length, thickness, diameter) in relation to their calcium and phosphorus in albino rats receiving different concentrations (Mean ± S.E.)

Parameters / Treatment	Length	Thickness	Diameter	Calcium	Phosphorus mg/g
Control	2.85±0.11	0.045±0.003	0.278±0.006	546.56±28.93	255.88±19.16
143 mg/kg B.Wt.	2.37±0.13 *	0.052±0.004 *	0.262 ±0.01	471.16±18.87 *	277.58±14.21
0.56 mg/kg	2.33±0.20 *	0.050±0.001 **	0.286±0.009	262.80±38.85 **	125.03±22.12 **
2.00 mg/kg B.Wt.	2.12±0.03 **	0.046±0.002 **	0.254±0.009 *	248.04±28.29 **	111.12±17.16 **

Table (3) : Effect of cadmium on serum and urine inorganic phosphorus and calcium in albino rats.

Treatment	Serum		Urine	
	Inorganic Phosphorus mg%	Calcium mg%	Inorganic Phosphorus mg%	Calcium mg%
Control	4.11±0.54	6.63±0.44	48.96±2.25	32.93±2.26
143 mg/kg B.Wt.	4.19±0.50	6.00±0.35	55.67±1.75 *	40.38±2.01 *
0.561 mg/kg	4.45±0.42	4.84±0.57	65.2±2.12 **	65.52±1.54 **
2.00 mg/kg B.Wt.	4.76±0.54	3.87±0.09 **	86.07±6.88 **	83.57±0.93 **

* Significant at $p < 0.05$
** Highty significant at $p < 0.01$
Non significant

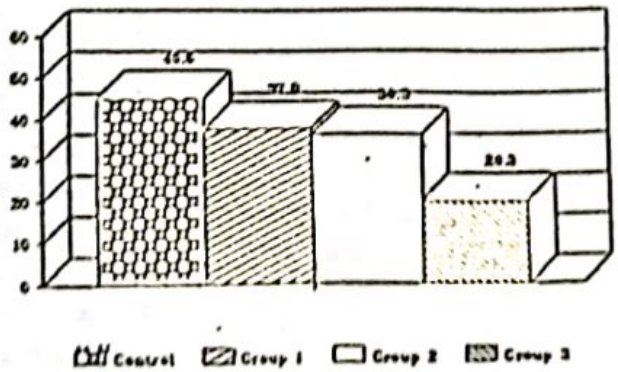

Figure (1) Effect of different concentrations of Cadmium on growth rate

increased excretion. In mean while the phosphorous showed increased

levels in both serum and urine in comparison to the control gorup.

DISCUSSION

The effect of different doses of cadmium on body weight showed non-significant decrease in the first group which represents the highest mean of cadmium in water in Egypt as well as the second gorup which equivalent to $^1/_{10}$ of LD_{50} while this decrease was highly significant in the third gorup which represents the effective dose. Such decrease was previously observed by (Friberg, et al. 1971, Abe and Itokawa, 1973 and Friberg, et al. 1974) they attributed this reduction by to the anaemia produced cadium toxicity, also hypoproteinaemia is another suggestion noted by Harper (1975) and supported by Blood and Handerson (1974).

On the other hand the mean growth rate in the three dosed groups showed a decrease in a dose dependant manner.

This results were previously recorded by some authors as Sugawara and Sugawara (1976); Sauter et al. (1976); Merali and Singhal (1977); Piscator et al. (1981) and Sastry and Subhadra, (1985), in rats, brook trout, rabbits and teleost fish and the last author found that the desease in B.Wt. in fish was associated with reduction in serum thyroxin concentration. However Schroeder et al. (1963) showed that the growth rate of cadmium treated animals was increased in relation to control and they attributed that to slow growth rate of the control.

Effect of cadmium on some measurements of bone (length, thickness, diameter) showed a decrease in such dimension especially in the effective dose in comparison to control. Such result is refered to the observed decrease in growth rate in cadmium treated animals (Sastry and Subhadra 1985).

Concerning the thickness of femur bone at the diaphesis there was a significant reduction in gorup 1 and highly significant in the 2 and 3 groups. These results seems to be due to loss of calcium from bone via serum and urine as function of cadmium accumulation (Watanabe, et al. 1986). Such result was supported by the present calcium and phosphorous levels.

Concerning inorganic phosphorous levels they showed non-signifcant increase in serum, while significant increase was attend in urine in a dose dependent manner. In contrast calium concentration in serum showed non-significant decrease in the first group and significant decrease in both second and third groups, such condition was accompanied by increased calcium excretion in urine regarding the dose. These results going well with Nogawa, et al. 1975, Scott, et al. 1976, Sakurai, et al. 1980, Nishiyama and Nakamura, 1984 and Watanabe et al. 1986.

Calcium decreased level observed in serum could be attributed to the sum of several factors as cadmium couse osteomalacia, also increase its excretion level in urine through inhibition of Ca, Na, K ATPase enzyme, also damage of mucous membrane of the gastrointestinal tract in case of cadmium toxicity will share in depreviation of blood from one of its calcium sources (Bartik and Piskac, 1980). While the increased level of phosphorous in urine was best clarified by Nogawa et al. (1975) who declaired that renal phosphorous reabsoption decreased among inhabitants of different pollutant areas in Japan.

Increasing contamination of the living environment in Egypt specially with cadmium will result in hazard effect as hypocalcemia, hypercalcuria, hypophosphataemia, reduction in grwoth rate and the biometrical dimension of bone as the start of such changes was observed in the animals administrered the level recorded in Egypt.

SUMMARY

A total of 80 albino rats were divided into 4 equal groups. The first 20 rats were kept as control and the other three groups were dosed orally by 0.143 , 0.561 and 2.00 mg/kg B.wt. respectively for 8 succisive weeks. The results revealed decrease in body weight in a dose dependant manner. Also the length, thickness of femur and thickness of diaphesis decreased in the same way while diameter decreased occurs in the third group only. Calcium content of bone showed a decrease in the three doses levels while phosphorus revealed such effect in gorups (1) and (2). Calcium revealed a decrease in serum and increased level in urine meanwhile the phosphours showed increase in both serum and urine.

REFERENCES

Abe, T. and Itokawa, Y. (1973): Experimental cadmium poisoning. III. Effect of cadmium on Na, K, Mg dependent ATPase, Mg dependent ATPase and transketolase. Japan J. Hyg. 28, 243.

Abou Salem, M. (1991): Some toxicological studies on some environmental pollutant. Ph D. Thesis, Fac. of Vet. Med. Zagazig. Univ. Banha Branch.

Bartik, M. and Piskac, A. (1980): Veterinary Toxicology. Elsevier Scientific publishing company.

Blood, D.C. and Handerson, J.A. (1974): Veterinary Medicine, 4th Ed. Williams and Wilkins Company, Blatimore, P. 784.

Friberg, L.; Piscator, M. and Nordberg, G.F. (1971): Cadmium in the environment CRC Press, Cleveland, Ohio.

Friberg, L.; Piscator, M.; Nordberg, G.E. and Kjellstrom, T. (1974): Cadmium in the environment 2nd. Ed. CRC Press, cleveland.

Gindler, E.M. and King, J.D. (1972): Rapid colorimetric determination of calcium in biologic fluid. Am. J. Clin. Path., 58: 377-382.

Harper, H. (1975): Review of Physiological chemistry, 15 th Ed. California: Large Medical Publication, Los anglos.

Kim, Y.K. Choi, J.K. Kim, J.S. and Park, Y.S. (1988): Changes in renal function in cadmium intoxicated rats. Pharmacology and Toxicology, 63, 342-350.

Kunimoto, M. and Miura, T. (1986): Density increment and decreased survival of rat red blood cells induced by cadmium. Environ. Rese. 39, 86 95.

Merali, Z. and Singhal, R.L. (1977): Long term effects of orally administered cadmium on neonatal rats. Proc. of the 1st intern. Congress on Toxico. Held March 30 -April, 2, in Toronto, Canada.

Ng, T.C.K. peraino, R.A. and Suki, W.N. (1980): Divalent cation transport in isolated tubules. Kidney Internat. 22, 492-497.

Nishiyama, S. and Nakamura, K. (1984): Effect of cadmium on plasma aldosterone and serum corticosterone concentrations in male rats. Toxicol. Appl. Pharmacol. 76, 420-425.

Nogawa, K. Ishizaki, A. Kobayashi, E. Inaoka, H. and Shibata, I. (1975): Studies on renal dysfunction of inhabitants in Cd polluted district. Jpn. J. Hyg. 30, 549-555 (in Japanese).

Nomiyama, K. (1980): In progress in water technology. Vol. Vit. 15-23 Pergamon press, Oxford. (C.F. Lauwerys, R. et al. (1977).

Piscator, M. Bjorck, L. and Nordberg, M. (1981): B_2-Microglobulin levels in serum and urine of cadmium exposed rabbits. Acta. Pharmacol. et toxicol. 49, 1-7.

Sakurai, H. Omae, K. Sugita, M. Kusumoto, M. Toyama, T. Adochi, S. Okubo, T. and Tsuchiya, K. (1980):

Sastry, K.V. and Subhadra, K.M. (1985): In vivo effects of cadmium on some enzyme activities in tissues of the freshwater catfish, heteropheustes fossilis. Environ. Rese. 36, 32-45.

Sauter, S. Buxton, K.S. Macek, K.J. and Petrocelli, S.R. (1976): Effects of exposure to heavy metals on selected fresh water fish. U.S. Environmental protection Agency, Ecological Res. Ser. No. EPA-600/3. 76-105.

Schroeder, H.A. Vinton, W.H. and Balassa, J.J. (1963): J. Nutr. 80: 48. (C.F. Pribble, H.J. and Weswig, P.H. (1973)

Scott, R. Mills, Fell, E.A., Husain, G.S.; Yates, F.E.R.; Paterson, A.J., Mckirdy, P.J., Ottoway, A., Filzgeraldfinch, J.M. Lamont, O.P. and Roxurgh, A. (1976): Clinical and biochemical abnormalities in coppersmiths exposed to cadmium. Lancet 21, 296-398.

Sugawara, N. and Sugawara, C. (1976): Effect of cadmium, in vivo and in vitro, on intestinal Brush Border ALPase and ATPase. Bull. of Environ. Contamin. and Toxicology. 14 (6): 653-656.

Tanaka, Y. Tanka, R. Kashimoto, T (1983): Studies on the fate of heavy metals in animals. II. Effect of cysteine on the LD_{50} and tranlsition of cadmium in rat.

Watanabe, M.; Shiroishi, K; Nishino H.; Shinmura, T. Murase, H. Shoji, T. Naruse, Y. and Kagamimori, S. (1986): An experimental study on the long term effect of cadmium in mice fed cadmium-polluted rice with special reference to the effect of repeated reproductive cycles. Environ. Res. 40, 25-46.

Zilversmit, D.B. and Dais, K. (1950): J. Lab. Clin. Med. 35 Bogatzki, Arch J.D. Eisenhutenwesen 12.