RESEARCH ARTICLE

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Assessment of effects of some industrial solvents on thyroid gland in albino rats

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ABSTRACT

Assessment of effects of some industrial solvents on thyroid gland was carried out in laboratory rats. The study was divided into three groups of five animals each. Rats of group 'A' were administered 0.2 ml of 2% carbon tetrachloride on each alternate day for fifteen days. Rats of group 'B' were administered toluene in the same way. Rats of group 'C' were administered olive oil alone to serve as controls. Observations on thyroid-body weight relationship and hormonal assay for T3 and T4 were recorded. Sex differences on their thyrotoxicity have also been studied. Significant results were observed in thyrotoxicity of toluene and carbon tetrachloride in both sexes of rats. Thyrosomatic index was higher in toluene treated female rats; however, in carbon tetrachloride treated rats the thyrosomatic index was high in male rats. Toluene stimulated the T3 and T4 secretion in female rats where as reverse occurred in male rats. Almost similar values were recorded in carbon tetrachloride treated rats. These results suggested that secretion of these hormones is affected by these solvents.
Key words: *Industrial solvents, Thyroid gland, Albino rats*

INTRODUCTION:

Many chemicals including industrial solvents induce changes in endocrine status of animals. For the normal growth and development of an individual, industrial solvents pose a serious risk of endocrine disorders in workers occupationally exposed to these solvents. Several compounds are capable of actively modifying the functional efficiency of the thyroid gland. They include drugs as well as environmental chemicals. Such agents generally operate by interference with the normal processes of thyroid hormone biosynthesis for example thiocyanate, perchlorate, nitrate and fluoroborate, are the inhibitors of iodide uptake by the thyroid gland.

Thyroid function is sensitive to the action of various chemicals of low concentration. Thyroid hyperplacia in rabbits given toxic doses of acetonitrite intramuscularly was reported by Marine *et al* (1933). Hyperthyroidic states have occasionally been reported from industrial poisoning by halogenated methanes (Krasnyuk 1964).

In contrast, ethanol perse can alter the thyroid hormones levels in adult animals creating a hypothyroid state (Portoles, *et al.* 1985). Absorption of benzene similarly results in stimulation of both thyroid and adrenocortical activity. The prolonged action of carbon monoxide at low exposure level depressed thyroid function (Truhaut, *et al.* 1965). Anti-thyroid agents might interfere in the manufacture of thyroid hormones largely by preventing the gland from inserting inorganic iodide into tyrosine residues.

Though a large wealth of information is available on the toxicity of industrial solvents like toluene, carbon tetrachloride; their thyrotoxicity remain poorly known. The present study was done to observe the effects of some solvents i.e. toluene and carbon tetrachloride on thyroid hormones i.e. T3 and T4 in laboratory rats. Sex differences on their thyrotoxicity have also been studied.

MATERIAL AND METHODS:

Albino rats of both sexes weighing 150-180 gm body weight, used for the study, were housed under standard laboratory conditions. They were fed with standard rodent pellets and water *adlibitum*. The animals were grouped into three groups of five animals each.

Group A: Rats were administered 0.2 ml of 2% carbon tetrachloride on each alternate day for fifteen days.

Group B: Rats were administered 0.2 ml of 2% Toluene on each alternate day for fifteen days.

Group C: Control (administered olive oil only)

After the treatment for 30 days rats of both sexes were sacrificed under light ether anesthesia. The blood samples were taken directly by cardiac puncture and centrifuged to obtain serum. Hormones like triiodothyronin (T3) and thyroxine (T4) were estimated following the solid phase radioimmunoassay method using a RIA kit, supplied by diagnostic products corporation, Los Angeles, California, U.S.A. These analyses were performed at a local pathology laboratory equipped with RIA facility.

RESULTS AND DISCUSSION:

Results are given in Table 1 and Table 2. These include observations on thyroid-body weight relationship and hormonal assay for T3 and T4. Carbon tetrachloride (CCL4) and toluene both decreased the growth of laboratory rats. The decrease caused by CCL_4 was higher in female rats than the male rats, however, in toluene treated rats no significant sex differences were observed. Thyroid-body weight relationship was higher in female toluene treated rats; however, in CCL_4 treated rats the thyrosomatic index was high in male rats. Observations on T3 revealed that Carbon tetrachloride and toluene significantly stimulated the secretion of this hormone in female rats. However, reverse observations were recorded in male rats, where a decline in T3 values was observed after toluene as well as CCL_4 treatments. Toluene stimulated the secretion of T4 in female rats, whereas, inhibited the secretion in male rats. In CCL_4 treated rats almost similar values were recorded in male as well as female rats.

Table 1: Observations on effects of toluene and carbon tetrachloride (CCL4) on thyroid gland in male laboratory rats

Treatment	Body wt. (g)		Weight gain/loss (%)	Thyroid wt. (g)	T_3 (ng/ml)	T_4 (ng/ml)
	Initial	Final				
Toluene	130±6.35	105±6.35	-19.23%	0.17±0.019	0.50±0.07	28.70±0.56
CCL_4	130±6.35	100±6.35	-15.40%	0.23±0.021	0.65±0.028	43.24±0.29
Control	130±6.35	145±6.35	+11.53%	0.32±0.019	0.67±0.02	44.20±0.35

Results are mean + S.E. for 5 observations (n=5)

Table 2: Observations on effects of toluene and carbon tetrachloride (CCL4) on thyroid gland in female laboratory rats

Treatment	Body wt. (g)		Weight gain/loss (%)	Thyroid wt. (g)	T_3 (ng/ml)	T_4 (ng/ml)
	Initial	Final				
Toluene	125±6.35	100±6.35	-19.23%	0.36±0.033	0.70±0.08	45.60±0.22
CCL_4	125±6.35	95±6.35	-23%	0.15±0.024	0.90±0.07	44.3±0.19
Control	125±6.35	140±6.35	+11.53%	0.15±0.024	0.55±0.02	38.04±0.14

Results are mean + S.E. for 5 observations (n=5)

Significant findings of the present study are as follows. Prolonged exposure to industrial solvents like toluene and CCL4 has been found to cause thyrotoxicity in rats. Significant results were observed in thyrotoxicity of these solvents in both sexes of rats. These solvents decreased the growth of laboratory rats. Thyrosomatic index was higher in toluene treated female rats whereas it was high in CCL4 treated male rats. Toluene and CCL4 stimulated the T3 secretion in female rats whereas reverse occurred in male rats. Almost similar results observed on T4.

The Thyroid gland is perhaps the only endocrine gland that stores its products extracellularly i.e. in the lumen of the follicle. This gland has the capacity to concentrate iodine to several hundred thousand times the concentration of this element in blood plasma. After the transport of iodine from the blood into the cells, it is oxidized in the presence of hydrogen peroxide to a different ionic species. The oxidized ion subsequently iodinates the tyrosine residues of thyroglobulin to form mono and diiodotyrosine. Triiodotyrosine is formed when one molecule each of monoiodotyrosine and diiodotyrosine are coupled. Thyroxine is formed when two molecules of diiodotyrosine are joined. The activity of thyroid is regulated by thyrotropin or thryroid stimulated hormone (TSH) of the anterior lobe of pituitary which in turn is controlled by thyrotropin releasing factor (TRF) of the hypothalamus. Chronic hypersecretion of thyrotropin results in highly vascular gland with columnar epithelial cells and relatively little colloid. Thus secretion of the thyroid hormones can be severely affected by ionic imbalance particularly that of iodine.

The most striking effect of thyroid secretion is the control of the metabolic rate of the body. When hypothyroidism begins, it leads to cretinism and enlargement of thyroid is called goiter. Due to these changes body can be severely affected. Excessive consumption of goitrogens may interfere with iodine in the thyroid and may result in its enlargement.

This information is further strengthened by the fact that hyperplastic and neoplastic responses of the rat thyroid may be induced by a number of chemicals. Some information is available on heavy metal toxicity on thyroid function in man and experimental animals (Zeltser 1962, Sandstead 1967, Sandstead *et al* 1969, Der *et al* 1977, Robins *et al* 1983, Shrivastava, *et al* 1987). It has been reported that percentage uptake of I_{131} is significantly reduced in metal treated rats suggesting that they inhibit the thyroid function.

Present results show that male and female rats respond differently to CCL_4 and toluene. The secretion of T3 and T4 in female rats might accompany hypersecretion of TSH influencing the hypothalamo-hypophyseal feedback mechanism. However, reverse may be expected for male rats. Another possible reason seems to be the inhibition of enzymes specially 5-thyroxine deiodinase which is involved in the conversion of T4 to T3 (Gregus, *et al,* 1988).

CONCLUSION:

Industrial solvents i.e. carbon tetrachloride and toluene has been found to cause thyrotoxicity in laboratory rats. The present study suggest that the secretion of thyroid hormones is affected by these solvents

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