Nephrotoxic effects of Nitrogen Dioxide Gas Exposure in Albino Rats

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Abstract: ***In the present study albino rats Rattus norvegicus (Berkenhout) were exposed to 40 ppm and 80 ppm nitrogen dioxide gas for 30 and 60 days for one hour per day. A decrease in serum creatinine, urea, potassium (K^+) ion, protein and increase in serum sodium (Na^+) ion levels after prolonged exposure to nitrogen dioxide gas. This study indicates that toxic effects of nitrogen dioxide gas exposure causes nephrotoxicity in albino rats.***

Keywords: Nitrogen dioxide, serum protein serum creatinine, serum urea, serum sodium (Na^+) ion and serum potassium (K^+) ion

1. Introduction

Nitrogen dioxide considered as a serious air pollutant. Toxic effects of nitrogen dioxide usually occur after the inhalation of the gas beyond the threshold limit value (update of WHO, 2008) Nitrogen oxides are released to the air from the exhaust of motor vehicles, the burning of coal, oil or natural gas and during processes such as welding, electroplating, engraving and dynamite blasting, burning a lot of wood or use of kerosene, heater and gas stoves. Nitrogen dioxide causes oxidative stress in the body by inducing the generation of free radicals. Blood parameters are an asset in diagnosis the structure and functional status of body organs to toxicants (Bansal et at., 1979). The kidney functions may be assessed from the level of serum potassium (K^+) ion, sodium (Na^+) ion, urea, creatinine and protein in the serum (Nwankwo *et al.*, 2006 and crook, 2007).

2. Materials and Methods

The albino rat, *Rattus norvegicus* (Berkinhout) of both the sex has been selected for the present investigation. The colony of the albino rats was inbred at the animal house of zoology Department ,60 healthy and adult rats ranging in weight from 100 to 120g were kept in polypropylene cages at temperature 25^0C ± 5^0C, relative humidity 60± 5% and photoperiod 12hrs/day. The rats were fed on commercial food pellets (Golden feed, New Delhi) and water ad libitum. The Nitrogen dioxide gas was prepared by saltzman method (saltzman, 1954) and modified by levaggi *etal* ,1972. Nitrogen dioxide generator was used for the generation of nitrogen dioxide gas and rats were exposed in fumigation chamber (model AP-07, SFC-120) manufactured by standard Appliances, Varanasi.

The experimental rats were grouped in five sets. One control set 'A' and four experimental sets 'B', 'C', 'D' and 'E' of twelve rats each. Control set 'A' while experimental set 'B' was exposed to 40 ppm nitrogen dioxide gas and experiment set 'C' was exposed to 40 ppm nitrogen dioxide gas with supplementation of antioxidant vitamin C (5mg/rat/day) for 30 and 60 days for one hour per day in the fumigation chamber. Five rats were taken after 40 days and remaining five after 60 day from control (A) and experimental sets (B, C, D and E) the rats were sacrificed.

3. Result and Discussion

Alteration in the level of serum protein, urea, creatinine, sodium (Na^+) and potassium (K^+) ions is the indication of nephrotoxicity due to nitrogen dioxide gas exposure in albino rats. The results of this study are shown in table:1.

A decrease in serum protein, urea and creatinine is the result of inflammatory action of the nitrogen dioxide gas, causes influx of protein from serum to the site of oxidant injury in albino rats (shimizu *et al*, 1986; Muller *et al*, 2001; Agarwal *et al*, 2006). Serum urea and creatinine are the end products of protein metabolism which is processed in the liver, so the concentration of urea, creatinine depends mainly on the metabolism of protein and amino acids (Varley *et al*, 1980; Pant, 1999). An increase in level of serum sodium (Na^+) ion with decrease in potassium (K^+) ion in rats is the result of toxic action of nitrogen dioxide gas. Kidney maintain the water electrolytes and acid base balance (Nicopon and Hejlasz, 1991) Hypokalemia condition due to alkalosis is caused by the kidney response to alteration in serum potassium and sodium ion (Suga *et al*., 2001).

Another explanation regarding ionic disorder is the respiratory distress due to the air pollution which stimulates respiratory centre and disturbs the acid base balance in the body and respiratory alkalosis develop due to air pollutants (Oehme *et al*., 1996).

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Table 1: Serum potassium (K^+) ion (meq/l), serum rum sodium (Na^+) ion (meq/l) ,serum creatinin ,serum urea ,serum protein in albino rats after exposure to nitrogen to nitrogen dioxide gas

		Control sets (S)	**Experimental sets (S)**	
		Control Sets	**Experimental Sets(Concentrations)**	
			40 ppm	**80 ppm**
Parameters	**Exposure days**	**Range**	**Range**	**Range**
		Mean ± S.Em	Mean ± S.Em	Mean ± S.Em
Serum Potassium (K^+)	30	(6.0 - 7.5)	(5.6 - 6.5)	(5.2 - 6.3)
		6.90 ± 0.29	6.04 ± 0.15^{s} ↓	5.92 ± 0.19^{s} ↓
	60	(6.5 - 8.0)	(5.0 - 6.0)	(5.9 - 6.0)
		7.18 ± 0.26	$5.68 \pm 0.19^{H.S}$ ↓	$5.26 \pm 0.19^{V.H.S.}$ ↓
Serum Sodium (Na^+)	30	(110 - 121)	(120 - 128)	(122 - 126)
		117 ± 2.03	122.60 ± 3.29^{S} ↑	$124.00 \pm 0.70^{H.S}$ ↑
	60	(110 - 116)	(166 - 119)	(116 - 120)
		113.40 ± 1.08	$117.40 \pm 0.51^{H.S}$ ↑	$118.00 \pm 1.58^{V.H.S.}$ ↑
Serum Urea	30	(32 - 40)	(22 - 36)	(22 - 35)
		37.20 ± 1.60	$31.20 \pm 2.90^{N.S}$ ↓	29.40 ± 2.10^{s} ↓
	60	(32 - 40)	(22 - 36)	(22 - 36)
		36.40 ± 1.44	$27.00 \pm 2.60^{H.S}$ ↓	$26.80 \pm 2.60^{H.S.}$ ↓
Serum Creatinine	30	(1.0 - 1.5)	(0.5 - 1.2)	(0.4 - 1.1)
		1.22 ± 0.12	0.72 ± 0.14^{S} ↓	0.72 ± 0.13^{S} ↓
	60	(1.0 - 1.5)	(0.5 - 1.0)	(0.4- 0.8)
		1.24 ± 0.10	$0.76 \pm 0.10^{V.H.S}$ ↓	$0.60 \pm 0.07^{V.H.S.}$ ↓
Serum Total Protein	30	(6.5 - 7.3)	(5.9 - 6.9)	(5.8 - 6.5)
		7.04 ± 0.17	$6.26 \pm 0.19^{H.S}$ ↓	$6.04 \pm 0.12^{V.H.S}$ ↓
	60	(6.9 - 7.6)	(5.9 - 6.9)	(6.0 - 6.9)
		7.12 ± 0.13	$6.18 \pm 0.18^{V.H.S}$ ↓	$6.18 \pm 0.19^{V.H.S.}$ ↓