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# Generator Emissions and Haemoglobinopathy in Rattus Rattus Linnaeus, 1758


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**ABSTRACT**

The study was conducted to observe the influence of generator emissions on the haemoglobin concentration and the probable degree of haemoglobinopathy of the common house rat, Rattus rattus Linnaeus, 1758 collected from Bareilly, Uttar Pradesh, India. The haemoglobin values were estimated in Group I (control) and Group II (experimental) which were exposed to generator emissions from 5KV diesel generator. The latter were further subdivided into four groups based on distance of exposure [Group A (2 feet) Group B (4 feet), Group C (6 feet), Group D (8 feet)]. The results indicated significantly lower values in exposed rats suggesting that the emissions adversely affected haemoglobin concentration and manifested in haemoglobinopathy expressed as anemia. The maximum fall in haemoglobin was recorded in rats exposed at 2 feet for 60 days (females 50%, males 47.9%). The findings infer that the fall in haemoglobin concentration recorded from generator emission-exposed rats may result in haemoglobinopathy expressed as anemia and maybe attributed to haemorrhage and haemolysis.

**KEYWORDS** Rattus rattus, generator emissions, haemoglobin

## INTRODUCTION

Diesel generator sets (gen-sets) are used routinely to supply electrical power. Hospitals, businesses, and small communities use gen-sets to help reduce costs by load leveling and to provide emergency power during blackouts (either scheduled or unscheduled). Recent power outages in India have led to large increases in the purchase of gen-sets, primarily for providing emergency power. In addition to providing value associated with load leveling and emergency power, gen-sets have the added value that they can be installed relatively rapidly.

Emission Standards for Diesel Engines were notified by the Environment (Protection) Third Amendment Rules 2002, at serial no. 96, under the Environment (Protection) Act (EPA), 1986. Emissions from new diesel engines used in generator sets have also been regulated by the Ministry of Environment and Forests, Government of India. The regulations impose type approval testing, production conformity testing and labeling requirements. However, most of these gen-sets are being rapidly installed in India with minimal concern for EPA emissions, focusing exclusively on providing backup power to avoid blackouts. The net effect of these events is an increase in air pollutants in India (mostly NOx).

Scant work has been done on effect of different components of generator emissions on various animal models, specially on rats, Rattus rattus. The normal composition of gases in air is $N_2$ (78-79%), $O_2$ (20-21%), $Co_2$(0.03%) and He, $CH_4$, Kr, and other gases are present in traces. Due to the rapid increase of the use of generators, the normal composition of air has been disturbed, resulting in various degrees of pollution. On one hand we use diesel, petrol and kerosene operated generators which cause much pollution and on the other hand LPG operated generators have recently come in the market which emit comparatively lesser emissions. Nevertheless, diesel and petrol generators are very commonly used which are causing pollution in the environment.

The present study has therefore been undertaken to recognize the relationship between pollution and haemoglobin concentration as haemoglobinopathy can cause a wide variety of diseases of the lungs and other organs of rat. Thus the information generated herein will be of use for surgeons, clinicians and investigators involved in the study of pathology of lungs and other organs. The haemoglobin concentration of control and exposed rats was investigated to observe the toxicity of exposure to diesel exhaust from 5KV generator on Rattus rattus.

## MATERIALS AND METHODS:

Male and female rats, Rattus rattus, trapped from the different areas of Bareilly were exposed to diesel generator emissions. The experiments were conducted according to the prevailing guidelines for animal care.

Five groups of male and female rats, containing 10 rats per group were made as follows:

Group – I : Control (unexposed).

Group - II: Experimental groups. Four experimental groups were made:

A: Exposed from 2 feet; B: Exposed from 4 feet; C: Exposed from 6 feet; D: Exposed from 8 feet.

### Collection of blood and haemoglobin estimation

Blood was collected from the ocular vein, immediately transferred into a sterilized vial containing a mixture of ammonium oxalate and potassium oxalate as anticoagulant and hemoglobin (Hb%) was estimated by cynamethemoglobin method used by Dacie and Lewis (1975). The data were then analysed significantly according to the method of student's t-test (Fisher 1963) for test of significance ($P<0.05$) level.

**RESULTS AND DISCUSSION:**

Table 1 Hb (gm%) value of male rats exposed from different distances at various time intervals (all values are mean ± SD)

| Time Intervals | Group I (Control) | Group II (Experimental) (Distance in feet) | | | |
|---|---|---|---|---|---|
| | | A (2.0) | B (4.0) | C (6.0) | D (8.0) |
| 10 Days | 14.4 ± 1.18 | 11.5 ± 0.92 | 13.3 ± 0.85 | 13.86 ± 0.6 | 12.4 ± 1.06 |
| 20 Days | 14.1 ± 1.22 | 10.9 ± 0.76 | 12 ± 0.50 | 13.86 ±0.41 | 14.2 ± 1.10 |
| 40 Days | 14.9 ± 0.34 | 11.4 ± 0.48 | 11.4 ± 0.68 | 13.3 ± 1.07 | 14.26 ±0.28 |
| 60 Days | 14.6 ± 0.50 | 7.6 ± 5.37 | 10.4 ± 0.50 | 14.1 ± 0.20 | 14.56 ±0.28 |

**Table 2 Hb (gm%) value of female rats exposed from different distances at various time intervals (all values are mean ± SD)**

| Time Intervals | Group I (Control) | Group II (Experimental) (Distance in feet) | | | |
|---|---|---|---|---|---|
| | | A (2.0) | B (4.0) | C (6.0) | D (8.0) |
| 10 Days | 14.9 ±0.19 | 10.3 ± 0.61 | 11.5± 0.52 | 13.9 ±0.43 | 13.3 ±1.40 |
| 20 Days | 14.5 ±0.74 | 10.0 ± 0.50 | 11.0 ± 0.50 | 14.8 ±0.90 | 13.8 ±0.88 |
| 40 Days | 14.5 ±0.61 | 09.03 ± 0.62 | 12.0 ± 0.5 | 13.8 ±0.71 | 13.9 ±1.80 |
| 60 Days | 14.6 ± 1.35 | 7.33 ± 5.18 | 11.5 ± 0.25 | 12.5 ± 0.98 | 14.6 ± 0.55 |

The results showed that there is a significant decrease in hemoglobin (Hb%) when Rattus rattus were exposed to the pollution exhaust from the diesel generator. A negative correlation between hemoglobin values and pollution was recorded. The maximum percentage fall in haemoglobin was recorded in rats exposed at 2 feet for 60 days (females 50%, males 47.9%) (Tables 1,2).

Lisiewicz and Rucinska (1990) demonstrated that inhalation of high levels of $NO_2$ cause a decline in the phagocyte function of macrophages and the production of antibodies. $SO_2$ inhalation can produce irritation in respiratory airways, and lipid peroxidation is some tissues (Haider, 1985). $SO_2$ and $NO_2$ inhalation can produce morphological changes in tracheal epithelium in passerine birds and small mammals (Llacuna et al. 1993, Gorriz et al. 1994).

Kucera (1980) reported that some mammals exposed to $SO_2$ showed polycythemia as a response to hypoxia. Baskurt et al. (1990) did not record any statistically significant difference in hematological parameters of rats exposed to 1 ppm $SO_2$ for 24 h. Field studies in small mammals from zones polluted by smelter emissions of $SO_2$ and heavy metals (Kucera 1980, 1988) and laboratory studies in small mammals exposed to $SO_2$ (Baskurt 1988) reported significant Hct and Hb changes. These studies reported a slight increment in Hct values, in contrast the results observed in the present study.

A decrease in Hct and Hb values was recorded in rats subjected to $NO_2$ inhalation (Lisievicz and Rocinska 1990). The Hct decrease observed in caged mice from the polluted zone could be attributed to a slight but insignificant decrease of both RBC and MCV.

The osmolality increase observed in M. musculus could result in a low hemolysis probability during a hypotonic shock. Peinado et al. (1992) reported an increase in osmolality when the erythrocyte size decreased. The smaller erythrocyte size would be advantageous for oxygen transport (Yamaguchi et al. 1987).

Air pollution can be caused by industries, automobiles, cigarettes smoke and generators. The present investigation shows a decrease in hemoglobin percentage below normal range after generator exposure from 2 feet distance at different time intervals. Significant change in haemoglobin ($P < 0.01$)was recorded after exposure from 2 and 4 feet distances causing anemia, when exposed from 2 feet distance, 33% mortality was recorded. Anemia signifies a decrease in the amount of oxygen reaching the tissue of the body. This is responsible for many of the symptoms in an anemic rat because deficient red cell production in the bone marrow may be due to generator exposure. Hemoglobin percentage is a routine investigation in detection of anemia and therefore of decline in haemoglobin observed in the exposed rats suggests haemoglobinopathy manifested as anemia in rats.

The present results infer that generator exhaust can be harmful for humans too and the data can be used to correlate similar effect on humans under different conditions of exposure.

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