Air pollution is a common problem in both developing and developed countries. It has become a serious threat to healthy life of human beings. Every year large quantities of pollutants are discharged into the air from the ever increasing production of goods and from the burning of fossil fuels to generate energy needed to sustain economic and social development. During 1975-1995, the Indian economy grew by 2.63 times, with industrial pollution growth by 3.47 times and vehicular pollution load by 7.5 times. Vehicular pollution accounts significantly to the total pollution generated in cities especially in developing countries like India. Motor vehicle engines emit many types of pollutants including nitrogen oxides, volatile organic compounds (VOCs), carbon monoxide and sulphur dioxide and lead, leading to poor air quality, posing environmental and health risks all over the world. Diesel exhaust is a complex mixture of both particulate and gaseous phase. The size of the particles in diesel exhaust is so small that they can deposit in the airways and alveoli. The particles consist of a carbonaceous core with a large surface area to which various hydrocarbons such as Polycyclic Aromatic Hydrocarbons (PAHs) and nitro-PAHs can be adsorbed. These PAHs compounds are potent mutagens and carcinogens. Motor vehicles emit toxic Hydrocarbons, including benzene, 1,3-butadiene, aldehydes, and polycyclic aromatic hydrocarbons (PAHs). PAH are emitted at a higher rate in the exhaust of diesel-fueled vehicles than gasoline-fueled vehicles. The reactions that form ground-level ozone also produce small quantities of other organic and inorganic compounds such as peroxycetyl nitrate (PAN) and nitric acid. PAHs are highly lipid-soluble and are absorbed by the lungs and gut of mammals. PAHs may penetrate into the bronchial epithelium cells where metabolism takes places. The carcinogenicity of individual PAH requires metabolic activations and conversion into their corresponding ultimate carcinogenic metabolites which are responsible for DNA alkylations and the initiation step in the complex mechanism, associated with chemically induced cancer. Some studies have suggested that lung function decline and respiratory diseases are associated with proximity to roads with heavy traffic, traffic density or exposure to traffic-related air pollution. Few studies have been conducted in India and methodological aspects of measuring polycyclic hydrocarbons (PAHs) in urban atmosphere.
MATERIALS AND METHODS

Study area: Rohtak city which is located at 70 km from Delhi (a metropolitan city) towards North having an area of 441100 ha was selected. Air pollution at Rohtak city is increasing day by day due to vehicular exhausts. The study was carried out at six different sites of Rohtak city during 2007-2009. The mean level of pollutants during the previous one year was recorded. To study the ambient air quality, six sampling sites viz University campus, Medical mor, Delhi bye pass, New bus stand, Bhiwani stand and Hissar road were selected in the city on the basis of vehicular density and population.

Sampling and Analytical Procedure: Particulate laden Polycyclic Aromatic Hydrocarbon (PAH) samples were collected on Whatman glass fibre filter paper by using High Volume Sampler. Samples were extracted with toluene using ultra sonic bath for about 30 minutes and repeated thrice for complete extraction. Extracted samples were pooled and concentrated using rotary evaporator and finally analysed on gas chromatography. Following PAHs were determined at Rohtak city: acenapthalene, fluoranthene, anthracene, pyrene, benzo (a) anthracene, benzo (b) fluoranthene, benzo(k) fluoranthene, chrysene, benzo (a) pyrene and benzo (ghi) perylene.

RESULTS AND DISCUSSION

The mean of Polycyclic Aromatic Hydrocarbons (PAHs) of all the sites are summarized in Table 1. The mean value of acenapthalene at University campus, Medical mor, New bus stand, Delhi bye pass, Bhiwani stand and Hissar road were 8.30, 5.29, 2.06, 9.50, 2.66 and 20.59 µg/m³ respectively. The maximum concentration was found at Hissar road and minimum concentration was found at New bus stand. The mean value of fluoranthene at Medical mor, Delhi bye pass, Bhiwani stand and Hissar road were 0.88, 1.87, 1.39and 5.79 µg/m³ respectively. Fluoranthene was not found at University campus and New bus stand. The maximum concentration was found at Hissar road. The mean value of pyrene at University campus, Medical mor, New bus stand, Delhi bye pass, Bhiwani stand and Hissar road were 1.84, 3.57, 1.58, 1.76, 2.18 and 7.91 µg/m³ respectively. The pyrene was found maximum at Hissar road and minimum at New bus stand. The benzo(a)anthracene was found only at Delhi bye pass (1.97 µg/m³) and Bhiwani stand (1.78 µg/m³). The mean value of chrysene at University campus, Medical mor, New bus stand, Delhi bye pass, Bhiwani stand and Hissar road were 1.38, 1.25, 1.67, 1.89, 2.48 and 4.53 µg/m³ respectively. The maximum concentration of chrysene was found at Hissar road. The mean value of benzo(b)fluoranthene at University campus, Medical mor, New bus stand, Delhi bye pass, Bhiwani stand and Hissar road were 7.19, 6.71, 4.92, 12.26, 2.24 and 14.59 µg/m³ respectively. The maximum concentration was found at Hissar road. The mean value of benzo(k)fluoranthene at University campus, Medical mor, New bus stand, Delhi bye pass and Hissar road were 2.94, 3.44, 2.73, 1.79 and 3.21 µg/m³ respectively. The value of benzo(k)fluoranthene was not detected at Bhiwani stand. The mean value of benzo (a) pyrene at University campus, Medical mor, Delhi bye pass, Bhiwani stand and Hissar road were 1.55, 2.20, 1.91, 4.55 and 7.34 µg/m³ respectively. The value of benzo(a)pyrene was not detected at New bus stand. The concentration of benzo(a)pyrene was found above the permissible limit(5 µg/m³) at Hissar road. The mean value of benzo(ghi)perylene at University campus, Medical mor, New bus stand, Delhi bye pass and Bhiwani stand were 2.95, 2.36, 0.91, 1.50 and 2.66 µg/m³ respectively. The value of benzo(ghi)perylene was not detected at Hissar road. Fig 1 shows the means of PAHs at all the sites.

The benzopyrene was observed above the permissible limit (5 µg/m³) at Hissar road (7.34 µg/m³). Motor vehicle emissions (especially diesel vehicles) make a considerable contribution to PAHs concentrations in air due to burning and incomplete combustion of diesel or gasoline. In the present study, an attempt has been made at quantification of the ambient concentrations of PAHs, namely, acenapthalene, fluoranthene, anthracene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k) fluoranthene, benzo(a) pyrene and benzo (ghi) perylene.

The study of Pramod and Chandra measured atmospheric particulate PAH concentrations were at two locations in Mumbai (formerly Bombay), India. Total PAH concentrations (seven compounds) at Saki Naka and Indian Institute of Technology (IIT) were 38.8 and 24.5 µg m⁻³. Pyrene and benzo(a)anthracene-chrysene were abundant at both sites while benzo(b)fluoranthene and benzo(k)fluoranthene were abundant, in addition, at the IIT site. The large amount of pyrene in the ambient samples in Mumbai is likely from cooking-fuel
Table 1. Levels of PAH at various selected sites

<table>
<thead>
<tr>
<th>PAHs (µg/m$^3$)</th>
<th>Uni. Campus</th>
<th>Medical Mor.</th>
<th>New Bus Stand</th>
<th>Delhi Bye Pass</th>
<th>Bhiwani Stand</th>
<th>Hissar Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthene</td>
<td>8.30</td>
<td>5.29</td>
<td>2.06</td>
<td>9.50</td>
<td>2.66</td>
<td>20.59</td>
</tr>
<tr>
<td>Fluorene</td>
<td>ND</td>
<td>0.88</td>
<td>ND</td>
<td>1.87</td>
<td>1.39</td>
<td>5.79</td>
</tr>
<tr>
<td>Anthracene</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>1.42</td>
<td>ND</td>
</tr>
<tr>
<td>Fluoranthrone</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>1.04</td>
<td>ND</td>
</tr>
<tr>
<td>Pyrene</td>
<td>1.84</td>
<td>3.57</td>
<td>1.58</td>
<td>1.76</td>
<td>2.18</td>
<td>7.91</td>
</tr>
<tr>
<td>B(a)anthracene</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>1.97</td>
<td>1.78</td>
<td>ND</td>
</tr>
<tr>
<td>Chrysene</td>
<td>1.38</td>
<td>1.25</td>
<td>1.67</td>
<td>1.89</td>
<td>2.48</td>
<td>4.53</td>
</tr>
<tr>
<td>B(b)fluoranthene</td>
<td>7.19</td>
<td>6.71</td>
<td>4.92</td>
<td>12.26</td>
<td>2.24</td>
<td>14.59</td>
</tr>
<tr>
<td>B(k)fluoranthene</td>
<td>2.94</td>
<td>3.44</td>
<td>2.73</td>
<td>1.79</td>
<td>ND</td>
<td>3.21</td>
</tr>
<tr>
<td>B(a)pyrene</td>
<td>1.55</td>
<td>2.20</td>
<td>ND</td>
<td>1.91</td>
<td>4.55</td>
<td>7.34</td>
</tr>
<tr>
<td>B(ghi)perylene</td>
<td>2.95</td>
<td>2.36</td>
<td>0.91</td>
<td>1.50</td>
<td>2.66</td>
<td>ND</td>
</tr>
</tbody>
</table>

Fig. 1. Concentration of PAH (µg/m$^3$) at different sites of Rohtak city.

(National Ambient Air Quality Standard for B(a) pyrene (5 µg/m$^3$))
combustion (animal manure, kerosene and liquefied petroleum gas) in addition to vehicular emissions. Pyrene and chrysene are also emitted from industrial oil burning while the low concentrations of benzo(a)pyrene indicate that wood burning is not a significant source. At the IIT site, primarily vehicular emissions along with cooking fuel emissions are the likely contributors while industrial oil burning is an additional contributor at Saki Naka, accounting for the higher concentrations of pyrene and chrysene/benz(a)anthracene. In urban areas vehicular emissions are likely to be the primary contributor to PAH concentrations with additional local contributors like cooking fuel or industrial emissions. Thus the results obtained in this study provide important information for controlling the air quality and decreasing the harmful effects of pollutants on the health of the residents. Therefore future study could be extended to evaluate status of human health. The study emphasis’s the need to consider air pollution and traffic-related air pollution as a widespread cause of impaired health.

REFERENCES

**Symptoms (%) of HPA and LPA subjects**

- Itching or Rash
- Chest illnesses
- Blocked nose
- Cough
- Shortness of Breath
- Eye irritation & watering
- Ear discharge
- Wheezing
- Breathing difficulty
- Phlegm production

**Fig. 1. Symptoms (%) of HPA and LPA subjects**

**Fig. 2. Pulmonary function test of different exposure groups of HPA subjects**

**Fig. 3. Pulmonary function test of different exposure groups of LPA subjects**

**Fig. 4. Pulmonary function test of different age-groups of HPA subjects**

**Fig. 5. Pulmonary function test of different age-groups of LPA subjects**