Research Journal of Chemical Sciences _____ ISSN 2231-606X
Vol. **5(8),** 1-6, August **(2015)** *Res. J. Chem. Sci.*

Determination of Polycyclic Aromatic Hydrocarbons in Atmosphere of the City of Lahore, Pakistan

Kalim I.[1, 2]*, Zahra N.[2], Nisa A.[2], Hina. S.[2], T. Fazeelat.[1]
[1]Department of Chemistry, University of Engineering and Technology, Lahore-54890, PAKISTAN
[2]Pakistan Council of Scientific and Industrial Research Laboratories Complex, Ferozepur Road, Lahore-54600, PAKISTAN

Available online at: www.isca.in, www.isca.me
Received 24th April 2015, revised 27th June 2015, accepted 4th July 2015

Abstract

The present study entails the determination and evaluation of potential risk due to Polycyclic aromatic hydrocarbons (PAH's) which is one of the known organic pollutants. There is very little information available regarding polycyclic aromatic hydrocarbons (PAHs), a persistent environmental pollutant in Lahore, Pakistan. This research was carried out by collecting atmospheric particulate matter with the help of high volume samplers from December 2013 to December 2014. From literature it was found that greater levels of PAH concentration were observed during winters due to changes in emission sources and the climatic effects. The sampling site was one of the busiest and heavy traffic areas named Yadgar Chowk, Lahore. PAH's quantified with the help of Gas Chromatography. The average total concentration of PAH was found to be 239 ngm$^{-3.}$ Among the determined polycyclic aromatic hydrocarbons Benzo (a) Anthracene (BaA) was found to be in highest concentration i.e. 58 ngm^{-3}.

Keywords: Polycyclic aromatic hydrocarbons (PAHs), potential risk, Lahore, gas chromatography.

Introduction

The polycyclic aromatic hydrocarbons or PAHs are the mutagenic and carcinogenic environmental pollutants which are produced by natural as well as anthropogenic sources[1]. PAH are the amongst those air pollutants which are very toxic and give way to degradation products having mutagenic and carcinogenic properties. These pollutants are such allergic agents as dangerous to the human health. PAH may be present in particulate and gaseous phases. They belong to the class organic compounds which are semi-volatile in nature. The classification of PAH between gaseous and particulate matter mainly depends on the conditions of atmosphere, characteristics of the aerosols, the type of interaction present between the aerosol and compounds, and the nature of atmospheric compounds[2].

Fossil fuels and biomass generate PAH when they undergo the process of combustion. There are many sources of combustion such as industries, automobiles, petroleum and coal burning, waste incinerators, and the power plants. The industrial and highly urbanized sites have the presence of PAH which comes from anthropogenic sources, generated as a result of reactions like pyrolysis and incomplete combustion of the fossil fuels and the organic matter containing H-C and C-C bonds which takes place at very high temperatures[3]. The vehicular exhausts of diesel and gasoline, debris of tire wear, power plants, particles of asphalt, and the re-suspension of soil causes the production of PAH in the atmospheres of urbanized areas, whereas, natural source of PAH includes volcanoes and the forest fires. Studies regarding the levels of PAH have demonstrated their distribution in the suspended particulate matter[4], wet-deposition[5], road dust[6] and gaseous phase[7].

Low IQ and childhood Asthama may cause due to high prenatal exposure to PAH[8]**.** Persistent and long-term exposure of PAHs can cause cancer to lungs and also can harm the reproductive and organ systems[9]. Recently, the interest in the use of passive air samplers to monitor levels of PAH's in occupational, residential, and remote environments have been increased due to severity of exposure to these organic pollutants[10-11]. Poly aromatic hydrocarbons are highly lipid-soluble and are absorbed from the lung, gut and skin of mammals.

It was found that air pollution from the traffic contains high proportion of polycyclic aromatic hydrocarbons (PAHs) which is a group of over a hundred different organic compounds[12]. The day by day increasing traffic pollution can be associated with important health risk factor not only for the workers in transport industry but also for the public. Pollution from road traffic is a major source of exposure to polycyclic aromatic hydrocarbons (PAHs) in the city of Lahore (Pakistan). The issue of traffic pollution in Lahore city needs to be addressed on priority[13].

In this study the atmosphere of heavy traffic area (Yadgar Chowk, Lahore) is evaluated for the presence of polycyclic aromatic hydrocarbons and the levels of PAH's are also reported.

Methodology

Overview of the Specimen Site: Lahore is 2nd largest city of Pakistan in terms of its share in total population of the country.

The total population of Lahore was 6,318,745 as per 1998 Census[14]. The Lahore city is capital of the Punjab province in Pakistan which is located between 31°15′-31°45′ N and 74°01′-74°39′ E. It is surrounded on north and west by the Sheikhupura District, east by Wahgah border (Pakistan-Indian Border) and by Kasur District from south side. The Ravi River passes away from the north side of Lahore[15-16]. Lahore city contributes about 13.2% in national economy with an average growth rate of 5.6 percent. Weather in Lahore is extremely hot and long in summers (months of May, June and July) when temperature ranges up to 40-48°C (104-118 °F); with monsoon and dust storms (rare). The monsoon season in Lahore starts from July to August, with heavy rainfall throughout the province. Moreover, the Lahore city has a dense transport system and industries which are causing serious damage to urban environment and human health. There exist a strong correlation between increased air pollution and prevalence of respiratory allergies, kidney damage, asthma and other health and mental disorders[17-20]. Throughout summers there is very high temperature along with the high relative humidity and more than enough sunshine which results in the change of the concentration as well as the chemistry of PAH.

Sampling: The high volume samplers were used to collect the air samples with 99% efficiency on the Whatman GFA Glass fibre filters[21]. The time period of collection was 24 hours with 3m height above level of the ground. Before sampling was done, acetone was impregnated on the glass fibres for the removal of any organic compounds. These glass fibres were properly stored in the desiccators until sampling was carried out.

Sample Analysis and Extraction: The concentrations of the particulate matter, TSP, PM_{10}, and $PM_{2.5}$ were obtained by drying and weighing the filters. Until the analysis had to be done, these filters were stored in the dark. The dichloromethane/n-hexane with the ratio 1:1 and volume 10ml was taken for the extraction of PAH. It was further fractionated with the help of column chromatography and 20ml of dichloromethane/n-hexane of 1:1 was used for the elution. Samples were extracted with toluene using ultra sonic bath for about 30 minutes and repeated thrice for complete extraction. Alternatively sample can be extracted using soxhlet extraction apparatus for about 8 hours. Extracted samples are pooled and concentrated using rotary evaporator and further cleaned up with cyclohexane using silica gel column chromatography and finally analyzed[22] on gas chromatograph (GC) using capillary column (HP-Ultra-2, 30 m) and flame ionization detector (FID).

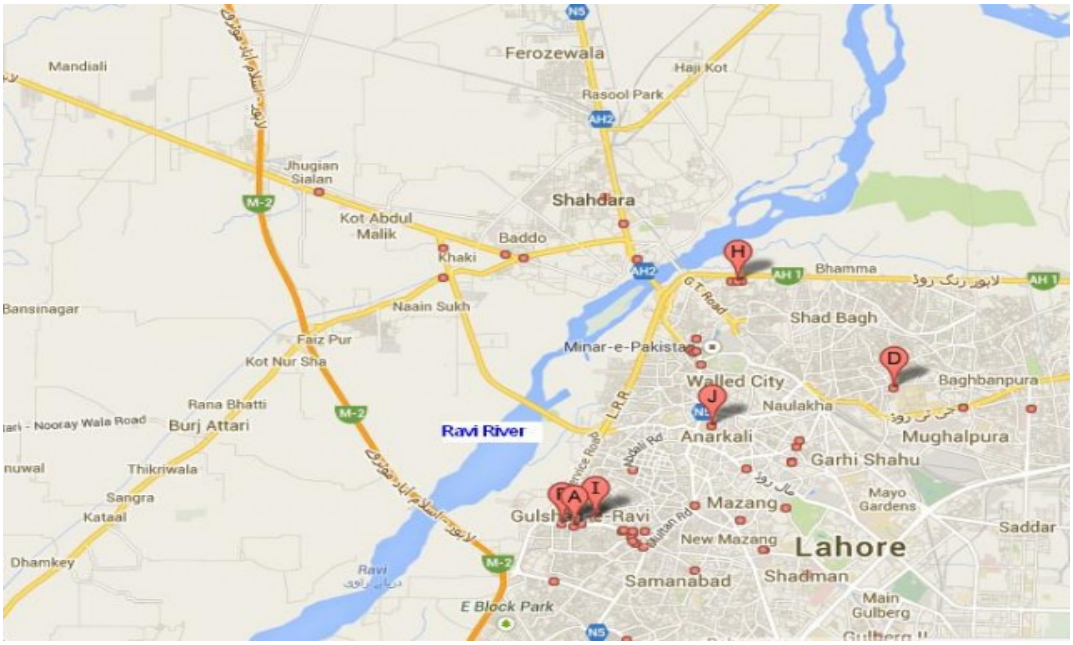
Statistical Analysis: One-way analysis of variance (ANOVA) was performed using SPSS 17.0 for Windows (IBM SPSS Statistics 19). The mean values were obtained by statistical analysis for each PAH.

Results and Discussion

Total 12 samples were collected and quantified for 16 PAH's during September 2013-December 2014. Total concentration of PAH was obtained by summing up the individual concentration of PAH compounds. The statistically sum up data is given in table-1

Source: www.skyscrapercity.com

Figure-1
Sampling site and its surroundings



Source: www. fjtown.com

Figure-2
Map showing the sampling site and its surroundings

Table-1
Statistical Summarized Data of PAH Concentration (ngm^{-3})

Sr. No.	PAH's	Min	Max	Mean
1.	Naphthalene (NAP)	4.6	19.8	12.3
2.	Acenephthylene (CAN)	7.8	14.4	9.6
3.	Acenaphthene (ACE)	0.001	7.2	7.2
4.	Phenathrene (PHE)	9.4	109.00	33.0
5.	Fluorine (FLU)	3.6	106.4	13.4
6.	Anthracene (ANC)	2.8	16.0	5.6
7.	Fluoranthene (FLA)	6.2	85.6	22.4
8.	Pyrene (PYR)	2.2	38.4	9.2
9.	Benzo(a)Anthracene (BaA)	31.2	102.2	58.8
10.	Chrysene (CRY)	11.4	31.4	20.2
11.	Benzo (b) Fluoranthene (BbF)	1.0	125.8	22.0
12.	Benzo (k) Fluoranthene (BkF)	0.2	59.0	11.0
13.	Benzo(a)Pyrene (BaP)	0.4	95.4	13.0
14.	Dibenzo (a, h) Anthracene (DBA)	8.2	181.6	40.8
15.	Indeno (1,2,3-c,d) Pyrene (IND)	0.002	24.6	0.6
16.	Benzo (ghi) Perylene (BgP)	12.4	72.6	21.0
TPAHs		30.4	784.6	239.0

The total concentrations of 16 PAHs varied from 30.4 to 784.6 ngm^{-3}, with a mean concentration of 239.0 ngm^{-3}. Long series transportation through atmosphere from heavy traffic area can also impact soils of that area. The World Health Organization (WHO 2010) most of all considers air pollution (by combustion systems and traffic), smoke from open fireplaces and tobacco smoke risks for humans of coming into contact with PAHs[23]. It was determined by Department of Health and Human Services (DHHS) that benz [a] anthracene and benzo [a] pyrene are probably carcinogenic to humans[24]. Numerous PAHs, including benz [a]anthracene, benzo [a] pyrene, benzo [b] fluoranthene, benzo [j] fluoranthene, benzo [k] fluoranthene, chrysene, dibenz [a,h] anthracene, and indeno [1,2,3-c,d] pyrene, were responsible for tumors in laboratory animals when they breathed these substances in the air. Studies of people show that individuals exposed by breathing or skin contact for long periods to mixtures that contain PAHs and other compounds can also develop cancer. As exceeded limits of PAHs is harmful to human health as well as concerns about the environmental behavior, so the global monitoring of the levels and distribution of PAHs is essential for risk assessment[25-26].

The PAH concentration of air varies from 5 to 200 ngm^{-3}, the concentration of PAH in urban areas can be tenfold higher than that of rural areas[27]. All mentioned levels in the present study exceeds the WHO acceptable level i.e. 0.01ng m^{-3}.

Conclusion

Studies have shown that the industrial emissive sources, vehicular traffic sources, and the incomplete combustion give way to the atmospheric pollutants like PAH. The average total concentration of PAH was found to be 239 ngm$^{-3.}$ Among the

determined polycyclic aromatic hydrocarbons Benzo (a) Anthracene (BaA) was found to be in highest concentration i.e. 58 ngm^{-3}. The PAH pollution in the city Lahore should be well managed by controlling the exhaust fumes of automobiles. This research based investigation needs further investigational work by sampling different other areas as one major factor which aggravates the generation of PAH is the climatic effect depending solely on the geographical strategies.

References

1. Xue W. L. and Warshawsky D., Metabolic activation of polycyclic and heterocyclic aromatic hydrocarbons and DNA damage: a review, *Toxicology and Applied Pharmacology*, **206**, 73–93 **(2005)**

2. Esen F., Tasdemir Y. and Vardar N., Atmospheric concentrations of PAHs, their possible sources and gasto- particle partitioning at a residential site of Bursa, Turkey, *Atmospheric Research*, **88**, 243–255 **(2008)**

3. Zielinska B., Sagebiel J., Arnott W. P., Rogers C.F., Kelly K.E. and Wagner D.A., Phase and size distribution of polycyclic aromatic hydrocarbons in diesel and gasoline vehicle emissions, *Environmental Science and Technology*, **38**, 2557–2567 **(2004)**

4. Hassan S.K., Atmospheric polycyclic aromatic hydrocarbons and some heavy metals in suspended particulate matter in urban, industrial and residential areas in Greater Cairo, Ph.D. Thesis, Cairo University, Egypt **(2006)**

5. Khoder M.I., Sources and distribution of polycyclic aromatic hydrocarbons in wet deposition in urban and suburban areas of Giza, Egypt, *Central European Journal of Occupational and Environmental Medicine*, **12**, 279– 296 **(2006)**

6. Hassanien M.A. and Abdel-Latif N.M., Polycyclic aromatic hydrocarbons in road dust over Greater Cairo, Egypt, *Journal of Hazardous Materials*, **151**, 247–254 **(2008)**

7. Hassan S.K. and Khoder M.I., Gas–particle concentration, distribution, and health risk assessment of polycyclic aromatic hydrocarbons at a traffic area of Giza, Egypt, *Environmental Monitoring and Assessment,* **184**, 3593–3612 **(2011)**

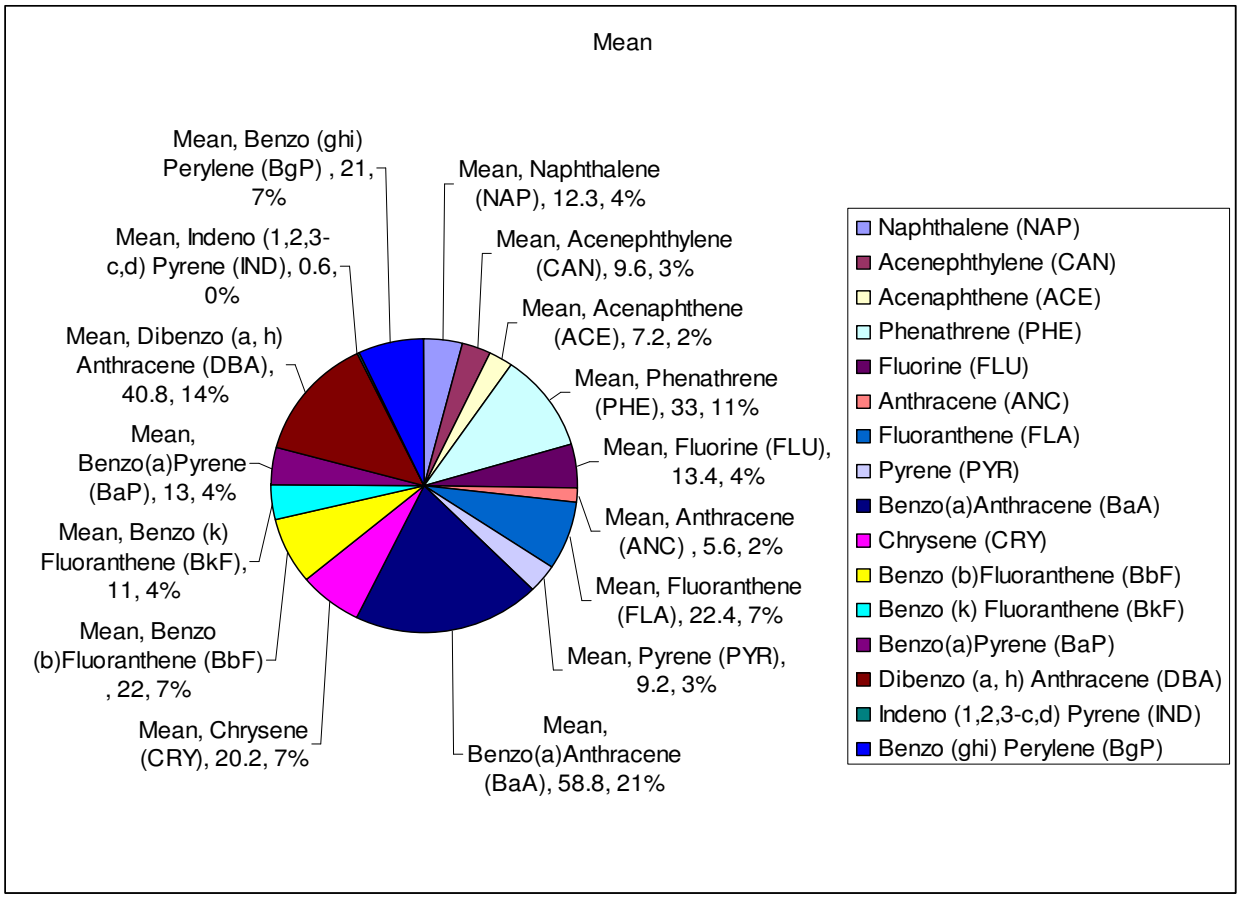


Figure-4
Mean values of PAH showing Contribution of the individual PAH compounds to the total PAHs

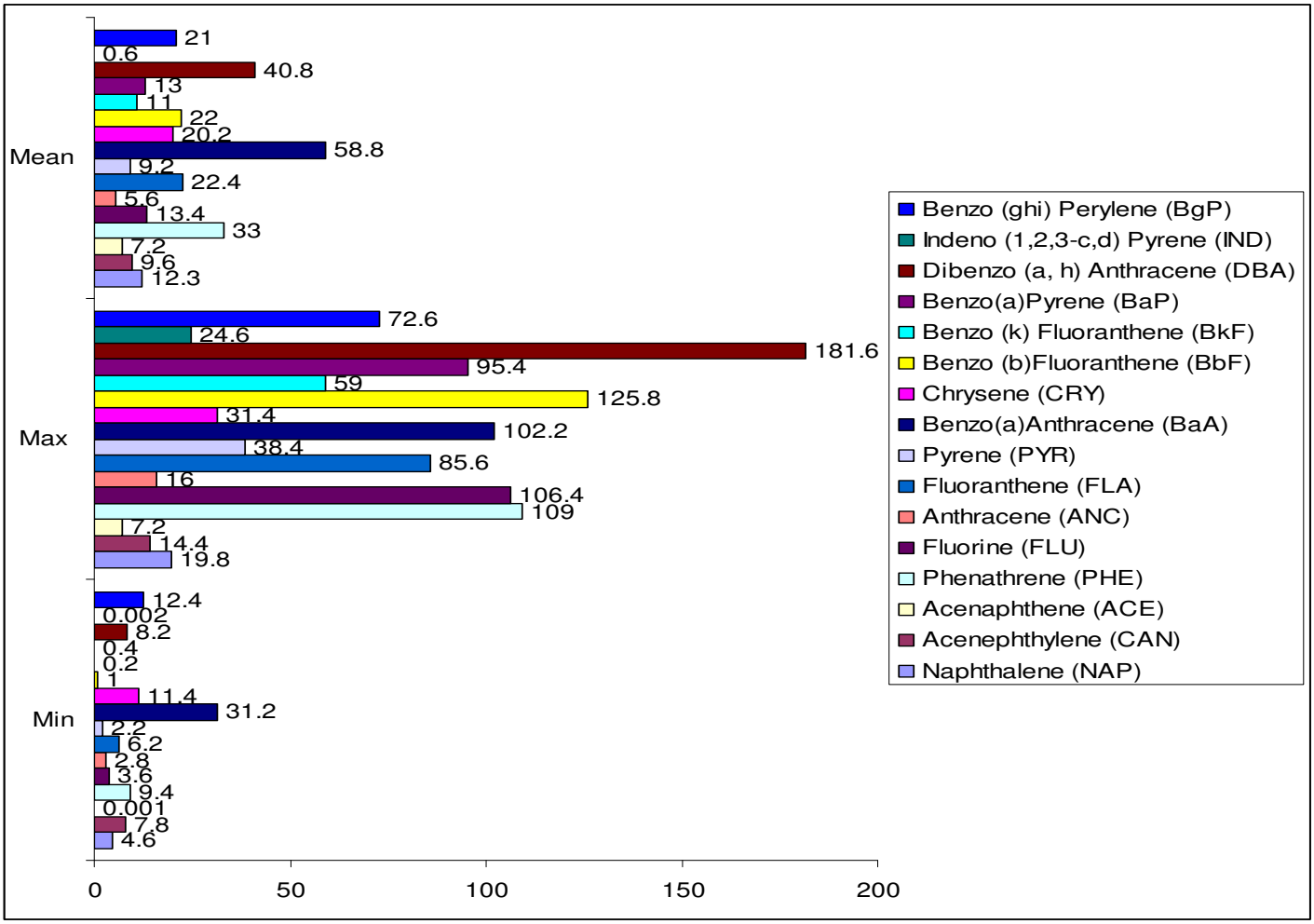


Figure-5
PAH's Minimum, Maximum and Mean Ranges

8. Exposure to Common Pollutant in Womb Might Lower IQ. 2014. *US News and World Report*, Retrieved 13 October **(2014)**

9. Polycyclic Aromatic Hydrocarbons- http://www.dhfs.state.wi.us/eh/ChemFS/fs/PAH.htm, **(2014)**

10. Bonetta S., Carraro E., Bonetta S., Pignata C., Pavan I., Romano C. and Gilli G., Application of semipermeable membrane device (SPMD) to assess air genotoxicity in an occupational environment, *Chemosphere,* **75**, 1446-1452 **(2009)**

11. Johnson M., Hudgens E., Williams R., Andrews G., Neas L., Gallagher J. and Ozkaynak H., A participant-based approach to indoor/outdoor air monitoring in community health studies. *Journal of Exposure Science and Environmental Epidemiology,* **19**, 492-501 **(2009)**

12. IARC, International Agency for Research on Cancer, IARC monographs on the evaluation of carcinogenic risks to humans. In: Air Pollution, Part 1. Some Non-heterocyclic Polycyclic Aromatic Hydrocarbons and Some Related Industrial Exposures, World Health Organization, Lyon, France, **92 (2010)**

13. Atif K. , Khansa Q., Muhammad G. , Muhammad A.A. and Riffat N.M., PAH exposure and oxidative stress indicators of human cohorts exposed to traffic pollution in Lahore city (Pakistan), *Chemosphere*, **120**, 59–67 **(2015)**

14. Safdar A.S. and Syed J.H.K., Analysis of Population Growth and Urban Development in Lahore-Pakistan using Geospatial Techniques: Suggesting some future Options, *South Asian Studies: A Research Journal of South Asian Studies,* **29**, 269-280 **(2014)**

15. Nevile P., A Sentimental Journey, Available at http://www.prannevile.com. Retrieved at 20-07-2010, **(2010)**

16. Lahore: the free encyclopaedia; available at www. Wikipedia.org. Retrieved at July 20 **(2010)**

17. Guo Y. L., Lin Y. C., Sung F. C., Huang S. L., Ko Y. C., and Lai J. S., Climate, traffic-related air pollutants, and asthma prevalence in middle-school children in Taiwan. *Environmental Health Perspectives,* **107**, 1001-1006 **(1999)**

18. Stott R., A major threat to the public's health in the twenty-first century, *Medicine Conflict and Survival*, **16**, 94-103, **(2000)**

19. Patz J.A., Engelberg D. and Last J., The effects of changing weather on public health, *Annual Review of Public Health,* **21**, 271-277 **(2000)**

20. Noreen A., Muhammad M., Bushra S., Munawar I., Inam U. and Shaukat A.S., Preliminary monitoring of tropospheric air quality of Lahore City in Pakistan, *International Journal of Chemical and Biochemical Sciences,* **3**, 19-28 **(2013)**

21. National Academy of Science (NAS), Particulate polycyclic organic matter, National Academy Press: Washington, D.C. **(1973)**

22. Dilip B., Polycyclic Aromatic Hydrocarbons (PAHs) In Air and Their Effects on Human Health - November 2003, Newsletter **(2003)**

23. WHO guidelines for indoor air quality: selected pollutants, WHO, Geneva **(2010)**

24. David S., Toxicological profile for polycyclic aromatic hydrocarbons U.S. department of health and human services, public health service agency for toxic substances and disease registry, Atlanta, Georgia **(1990)**

25. Ravindra K., Sokhi R., Van Grieken R., Atmospheric polycyclic aromatic hydrocarbons: Source attribution, emission factors and regulation, *Atmospheric Environment,* **42,** 2895–2921 **(2008)**

26. Liu G., Yu L., Li J., Liu X., Zhang G., PAHs in soils and estimated air–soil exchange in the Pearl River Delta, south China, *Environmental Monitoring and Assessment,* **173**, 861–870 **(2011)**

27. Skupinska K., Misiewicz I. and Kasprzycka-Guttman T., Polycyclic aromatic hydrocarbons: physicochemical properties, environmental appearance and impact on living organisms, *Acta Poloniae Pharmaceutica,* **61**, 233-40 **(2004)**

28. www.prannevile.com, **(2015)**