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Extraction of Polyaromatic Hydrocarbons from the Leachate of Major Landfill Sites of Delhi

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Abstract – Disposal of solid waste generated from Municipalities is of worldwide concern. The major concern arises from the developing countries across the globe, the reason behind this was an increase in poverty, population growth and growing urbanization. Leachates generated from Municipal Solid Waste landfills are defined by their physicochemical characteristics including organic and inorganic pollutants. There are many recommended guidelines to avoid leachate contamination to the environment but if it reaches in the vicinity, it may be hazardous and cause lethal effects in the living organisms. The present study focuses on three major landfill sites of Delhi- Bhalswa, Ghazipur, and Okhla. The objective of the study is to analyze Polyaromatic Hydrocarbons contamination in Leachate. The outcome of results shows the presence of different Polyaromatic hydrocarbons (PAHs) in leachate sample. Hence, present study plays a crucial role in determining the composition (Organic compounds i.e PAHs) of leachate which are toxic in nature, when get mixed with nearby water bodies of low lying areas which are the ultimate source of water to surrounding flora and fauna may prove lethal to them.

Keywords: Landfill Leachate, Gas Chromatomatoraphy, Polyaromatic Hydrocarbons, Toxicity

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1. INTRODUCTION

In India, solid waste management generated from municipalities acts as a major crisis in the previous decades. The reason behind this is the change in the lifestyles of people It is due to changing lifestyles of people that complement the developmental activities that are mostly unplanned and proliferation in industrialization and urbanization. Due to this quantity and characteristics of generated waste have changed due to which management of solid waste has become painful Ramachandra (2006).

In developed and developing nations of the globe, disposal of waste at landfill sites act as the cheapest, most cost-effective method and simplest method. (Barrett and Lawlor, 1995). Wastes located in landfills are subject to permeate by downpour and as water discharge through the accumulated waste it carries a range of organic (volatile organic compounds, phthalate esters, etc.) and inorganic compounds (trace metals) that move out of the wastes to mount up at the bottom of the landfill (Bhalla et al., 2012). Discharge of surplus rainwater through the heap of waste helps in generation of leachate. This percolating water further help in transferring of Pollutants through the amalgamation of Physico-chemical and microbial processes (Christensen and Kjeldsen(1989).

Leachate includes various inorganic as well as organic wastes. Industrial waste dispose of nearby industrial area are a major source of polyaromatic compounds which leaches down from topsoil and percolate down to join leachate. The number of rings present in PAHs determines its stability in the environment. Highly stable PAHs present in the environment is made up of two or more aromatic rings. Toxicity of these PAHs varies from mutagenic to teratogenic effects and finally carcinogenic effects on animals (Tang et al.,2005).

2. MATERIAL AND METHODS

2.1 Sampling and Reagents

The study area chosen for sampling are the three landfill sites of Delhi namely - Okhla, Bhalaswa and Ghazipur. These landfill sites are non-engineered resulting in continuous groundwater contamination. Triplicate of each sample were collected in plastic bottles (1 Litre) from the three landfill sites. The temperature during sampling was 37.5±1ºC. Sample bottles were previously marked and labeled to avoid mixing/confusion among samples. Collected samples were kept in the icebox and brought to the laboratory for further analyses. Reagents (Chloroform) used for extraction of PAHs were of HPLC grade.SS EPA 610 PAH mix standard varied in methanol: methylene chloride (1:1).

2.2 Microextraction of Polyaromatic compounds

Leachates contain a huge amount of organic waste and among them, polyaromatic hydrocarbon compounds occupy a large percentage. PAHs extraction from aqueous samples is carried out by Liquid-liquid extraction method which forms the most extensively used method for the removal of PAHs from watery samples (Ozcan et al, 2010).This technique is derived from the fetching of an analyte from an aqueous phase into the organic solvent phase which is immiscible with water (Andruch et al,2013). In this process, 5ml of leachate sample from all three sites (Bhalswa, Gazipur, Okhla) were taken in separate 50 ml conical flask and 5ml of chloroform was added to each. It was then placed in ultrasonicator for 15 min. During ultrasonication, process the solvent used for extraction is in vigorous contact with the solution containing the sample, that results in its dispersion right through the aqueous phase and an emulsion is produced; the analyte is then extricated into organic phase to break the interference between leachate and chloroform. Further, this sample is transferred in centrifugation tube and kept for centrifugation at 1500rpm for 5min at a temperature of 12℃. Subsequently, the organic solvent having the expected analyte is taken out with the help of a syringe which is afterward analyzed using GC-MS technique.

2.3 GC Conditions

The Identification of PAHs was done by Gas chromatomatoraph (GC-QP2010 Plus). GC was operated under following conditions: GC was furnished with AutoSampler AOC-20i+s , capillary column was made up of diphenyl dimethyl polysiloxane fused silica and carrier gas used was N_2/Air at a steady flow rate of 1.21 mL/min. Injections were performed by an autosampler AOC-20i+s. the oven temperature of Gas chromatomatoraph was as follows: initially temperature was kept at 110 ℃ for 0.5 min, then 1℃/min to 110℃ hold for 5 min, and finally 5℃/min to 320℃ hold for 8 min, run time for individual sample was 55 min. External PAH standards containing mixture of 16 PAHs were used to draw Analytical curves. Retention times of 16 PAHs were matched with that of leachate samples with ± 0.1 min as an acceptable limit.

3. RESULTS & DISCUSSION:

3.1 PAHs Identification

Fraction of polyaromatic hydrocarbons were extracted by USAEME (Ultrasound assisted emulsification microextraction) method in chloroform. The extract was analyzed in Shimadzu QP-2010P Plus gas chromatograph. External standard was used for identification of PAHs. Table 1. shows the presence of following PAHs in leachate sample namely Naphthalene, Acenaphthene, Acenaphthylene, Fluorine, Phenanthrene, Benzo (g,h,i) perylene, Chrysene, Benzo(a)antharacene, Fluoranthene, Benzo(b) fluoranthene, Pyrene, , Dibez (a,h) anthracene, Anthracene, Benzo (k) fluoranthene were identified in leachate sample from Bhalswa, Ghazipur and Okhla by comparing retention times of the samples to that of standards.

Table1: PAHs identified with respective retention times(RT) of leachate samples and standards

S. No.	PAHs	Bhalswa (RT-min)	Ghazipur (RT-min)	Okhala (RT-min)	Standards (RT-min)
1	Naphthalene	13.258	13.253	13.254	13.386
2	Acenaphthene	14.658	14.222	14.224	14.239
3	Acenaphthylene	16.512	16.507	16.507	16.587
4	Fluorine	21.038	21.033	21.036	21.085
5	Phenanthrene	---------	21.192	21.178	21.298
6	Anthracene	26.659	26.652	26.919	26.823
7	Fluoranthene	27.924	27.608	--------	27.793
8	Pyrene	33.604	33.599	33.609	33.611
9	Benzo(a)antharacene	33.859	33.85	33.867	33.810
10	Chrysene	38.25	38.251	38.26	38.55
11	Benzo(b)fluoranthene	----------	38.808	--------	38.64
12	Benzo(k)fluoranthene	39.688	39.687	39.690	39.782
13	Benzo(a)pyrene	----------	---------	---------	44.042
14	Indeno(1,2,3-CD)pyrene	----------	---------	---------	44.201
15	Dibez(a,h)anthracene	44.967		45.055	44.978
16	Benzo(g,h,i)perylene	48.814	48.805	48.816	48.815

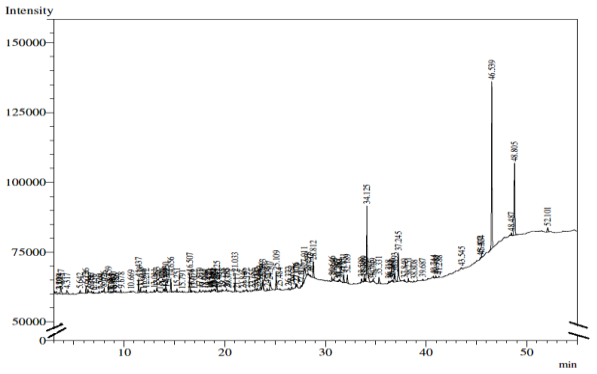

Fig.1: Chromatogram of PAH fraction of leachate from Gazipur landfill site.

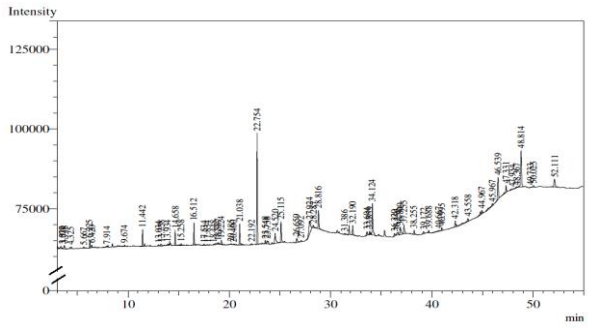

Fig.2: Chromatogram of PAH fraction of leachate from Bhalswa landfill site

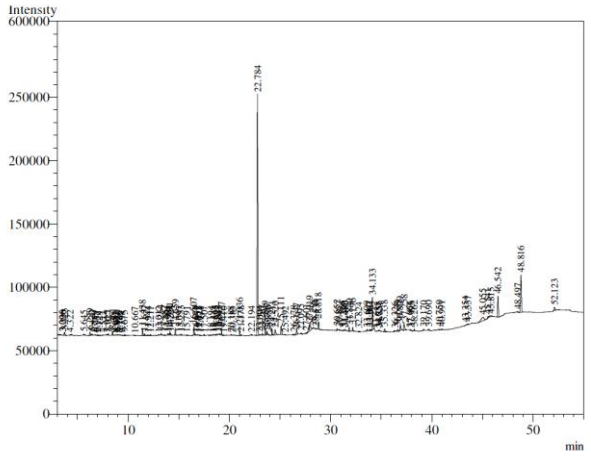

Fig.3: Chromatogram of PAH fraction of leachate from Okhla landfill site.

Fig. 1,2 and 3 show chromatogram of PAHs extracted from leachate of Gazipur, Bhalswa, and Okhla landfill sites respectively. Where each peak shows the retention time of different organic compounds. The outcome of results shows the presence of toxic organic compounds like PAHs in leachate. Our results are in line with Ghosh et al., (2015) who has found out several xenobiotics in landfill leachate which includes phthalate esters, polycyclic aromatic hydrocarbons, and several aliphatic compounds. Landfill leachate is full of phthalate esters, benzene and its derivatives and PAHs are genotoxic in nature. Discharge of leachate from landfill sites is of rising concern, mainly due to their lethal impact when they are released abandoned into the surrounding environment, and their possibility to promote leachate formation after many years of their closure (Christensen et al., 1992).

Hence present study suggests the harmful effects of leachate which get mixed with nearby water bodies of low lying areas which are the ultimate source of water to them. Hence it can be an important study to determine the water pollution caused by landfill leachate in low lying water bodies in nearby area and its toxic effect on plants growing around them.

4. CONCLUSION:

The result of the findings concluded that PAHs were identified in the leachate samples. Most of them are lethal to living organisms. Therefore improper maintenance of landfill leachate may be hazardous to the organisms and environment. Therefore it requires suitable guidelines and environmental quality standards for the discharge of leachate from landfills sites.

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