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## Comparative Study of Nitrated Aromatic Hydrocarbons in Drinking Water samples taken from Hattar industrial area, TIP housing society, Hazara University Dhodial Mansehra and Kahuta industrial triangle Islamabad, Pakistan

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**Abstract:** *Objective:* Polycyclic aromatic hydrocarbons are teratogenic and mutagenic, for their determination 50 water samples were taken from Hattar industrial area, TIP housing society, Hazara University Dhodial Mansehra and Kahuta industrial triangle Islamabad. *Methods:* Samples were analyzed with the help of High Pressure Liquid Chromatography for the determination of 5 Nitro PAHs including: Nitronaphthalene (NN), Nitrofluorine (NF), 9- Nitroanthracene (NA), 3-Nitrofluoroanthene (NFA), Nitropyrene (NP). *Results:* Maximum amount 1ng/L of 1-NN was detected in the water samples of Industrial Estate, Hattar. The samples taken from Hattar industrial Estate phase 1, 3-nitro PAHs were detected in different concentration, 9-NA = 0.4ng/L, 2-NF = 0.637ng/L in 1<sup>st</sup> sample and 0.34ng/L in 2<sup>nd</sup> sample, 1-NP 0.66ng/L, 0.21ng/L and 0.5ng/L in 3 different samples. The samples taken from Hattar industrial Estate phase 1V, 4-nitro PAHs were detected 1-NN = 1ng/L, 0.69ng/L, 2-NF = 0.9ng/L, 9-NA = 0.87ng/L and 1-NP = 0.4ng/L. The sample taken from Kahuta Industrial Triangle, 4 nitro PHAs were detected 1-NN = 0.42ng/L, 2-NF = 0.87ng/L, 0.63ng/L, 9-NA = 0.78ng/L and 3-NFA = 0.1ng/L. The sample taken from Industrial Estate I-9 Islamabad, only one nitro PAH 9-NA = 0.41ng/L was detected. The samples taken from TIP Housing Society, Industrial Zone Rawat Islamabad, Abbottabad, Qalanderabad, Dhodial Mansehra and commercial bottle of any beverages no nitro PAHs were detected. Bottled drinking water was also checked and no appreciable concentrations of nitro polycyclic aromatic hydrocarbons were detected in these samples. *Conclusion:* It is concluded that commercial water supplies are safe for health. The underground water near industrial areas particularly Hattar industrial area is not good for human use. While Rawat Industrial Zone is well planned for water supply and drainage so there no nitro PAHs were detected.

**Keywords:** Polycyclic aromatic hydrocarbons; High Pressure Liquid Chromatography; Islamabad; Nitronaphthalene; Nitrofluorine; 9- Nitroanthracene; 3-Nitrofluoroanthene

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### 1. INTRODUCTION

Polycyclic aromatic hydrocarbons (PAHs) occur in oil, coal, and tar deposits and are produced as byproducts of fuel burning (whether fossil fuel or biomass)<sup>1,2</sup>. Some compounds have been identified as carcinogenic, mutagenic, teratogenic and potent atmospheric pollutants<sup>3</sup>. September 2012, NASA scientists reported results of analog studies *in vitro* that PAHs, subjected to interstellar medium (ISM) conditions, are transformed, through hydrogenation, oxygenation, and hydroxylation, to more complex organics "a step along the path toward amino acids and nucleotides, the raw materials of proteins and DNA, respectively"<sup>4</sup>.

In a study evaluating the genotoxic and carcinogenic risks associated with the consumption of repeatedly heated coconut oil (RCO), one of the commonly consumed cooking and frying medium, it was concluded that dietary consumption of RCO can cause a genotoxic and preneoplastic change in the liver<sup>5-9</sup>. Nitro-PAHs may be metabolized by ring oxidation, nitro reduction, as well as conjugation reactions. Some of these reactions may lead to reactive metabolites that can covalently bind to macromolecules including DNA. Reactive epoxides may be formed by various CYP enzymes<sup>6,10,11</sup>. The pollution of the environment by Nitroated polycyclic aromatic hydrocarbons is becoming a greater than ever ecological alarm. The interest and aim of this subject is to study that how much these compounds effect the health of human beings<sup>7,12</sup>.

The main objective of this research was to study the continual increased threat to the environment and human's wellbeing, to aware the Government as well as Environmental protection agencies about these carcinogenic compounds and their effects on health, to aware the ministry of environment that they should monitor/ check the waste treatment of industries and to aware the industrialists that they should provide safe/ pure drinking water to their employers

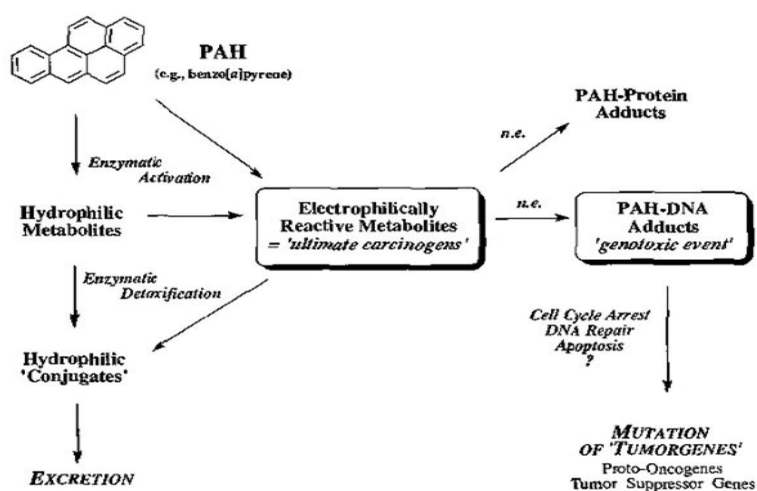


Figure 01. Strong role of polycyclic aromatic hydrocarbons as carcinogen

## 2. MATERIALS AND METHODS

### Experimental Design

Fifty water samples from Hattar and Islamabad Industrial areas, residential area of TIP housing society, Jinnahabad and Hazara University as well as bottled water were analyzed for the presence of 1-Nitronaphthalene, 9-Nitroanthracene, 3-Nitrofluoranthene, 2-Nitrofluorene and 1-nitropyrene Nitro-PAHs. The analyses were performed by using an HPLC chromatograph. Individual Nitro-PAHs were identified through both retention time matches with authentic standards<sup>13,14</sup>.

### Sample collection and storage

Samples were collected in containers made up of amber color glass bottles in refrigerator. All samples were kept at 4°C. pH is adjusted of the sample to <2 with 6N HCl to inhibit biological activity. All samples were extracted and completely analyzed within thirty days of extraction<sup>11</sup>.

### Extraction procedures:

For liquid-liquid extraction, 100 ml of water sample having 0.75 mg/liter peranalyte was extracted with 30 ml aliquots of methylene chloride. The combined extract was poured through a column having 10 cm of sodium sulfate (anhydrous), and the extract was collected. Flask and column was rinsed with 20 mL of methylene chloride. The organic solvent is evaporated in to dryness in the evaporative flask. The residue is resuspended in 4 mL of acetonitrile and refrigerated (4°C) to store<sup>15,16</sup>.

### Solid-Phase Extraction (SPE)

Water sample was collected and filtered through a 0.45µm filter. About 20ml of water sample was collected by passing through C18 Column. Take 5ml from it in test tube, add 5ml of filtered methylene chloride and evaporate at water-bath. Cooled and 5ml of acetonitrile was added<sup>12</sup>.

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**Chromatographic Conditions:**

HPLC (Isocratic) with UV detection was used for separation and quantification of Nitro-PAHs. 35: 65 v/v mixtures of Acetonitrile and water were used as mobile phase (1ml/min.)<sup>17</sup>. Sample loop was of 0.1 ml volume<sup>12, 13</sup>. Every nitro-PAH was detected in definite wavelengths which were shown as follows: 9-NA at 250nm, 2-NF at 250nm, 3-NF at 230nm, 1-NP at 230nm and 1-NP at 210nm

**3. RESULTS AND DISCUSSION**

The study consisted of fifty (50) water samples from different areas of Abbottabad, Mansehra, Haripur and Islamabad. Different sources of water like tube well, tape water and bottled water were selected for this purpose. These samples were analyzed for nitro polycyclic aromatic hydrocarbons and compared with standard chromatogram in which we intentionally injected Nitro PAHs at the concentration of 10µg/L. As shown in Chromatogram of Standard. The results are presented in table 1 to 10.

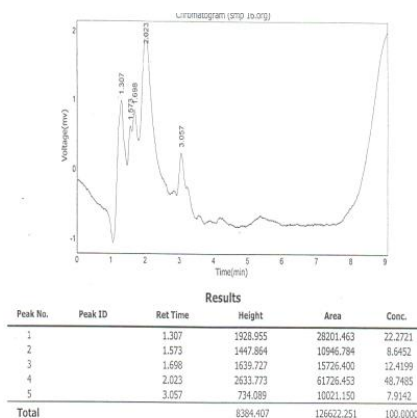
**Sample Taken From Hattar Industrial Estate (Phase I)**

Samples were collected in the vicinity of Hattar Industrial area Phase I. In these samples all the five nitro PAHs were detected because it is industrial area where a number of factories are working including Ghee Mills, Steel Mills and paper Mills. One of the reasons of the presence of Nitro PAHs in water is inadequate sewage system and improper waste disposal of the factories.

In Hattar Industrial area Phase I there are three nitro-PAHs detected. These are: 9-NA, 2-NF and 1-NP. Concentrations of the Nitro-PAHs detected in Hattar Industrial area are shown in table 1 (in ng/L). In sample 1 from Hattar Industrial Area 9-Nitroanthracene is detected with a concentration of 0.41ng/ L which is shown in table 1 and figure 9. In sample 2, 3 and 5 1-NP was detected concentration of 0.66, 0.21 and 0.5ng/L respectively and shown in figure 10, 11 and 13 while in sample 4 and 6, 2-NF was detected at the concentration of 0.637 and 0.34 ng/L respectively shown in figure 12 and 14

**Table 1: Water sample taken from Hattar Industrial Estate (Phase I)**

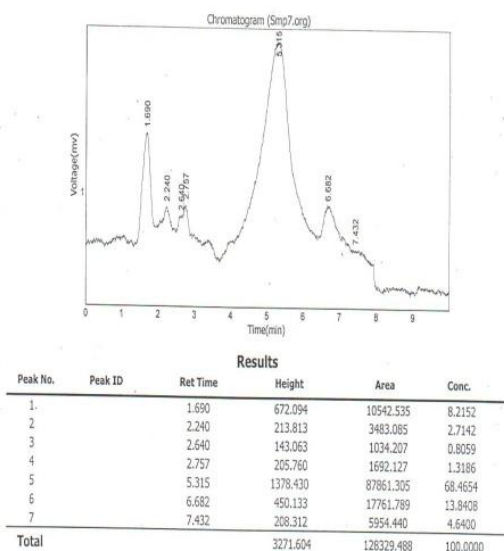
Smp. #	Nitro PAHs (ng/ L)				
	1-NN	2-NF	9- NA	3- NFA	1- NP
I	---	Nil	0.41	---	---
II	---	Nil	----	---	0.66
III	---	Nil	----	---	0.21
IV	---	0.637	----	---	---
V	---	---	---	---	0.5
VI	---	0.34	---	---	---



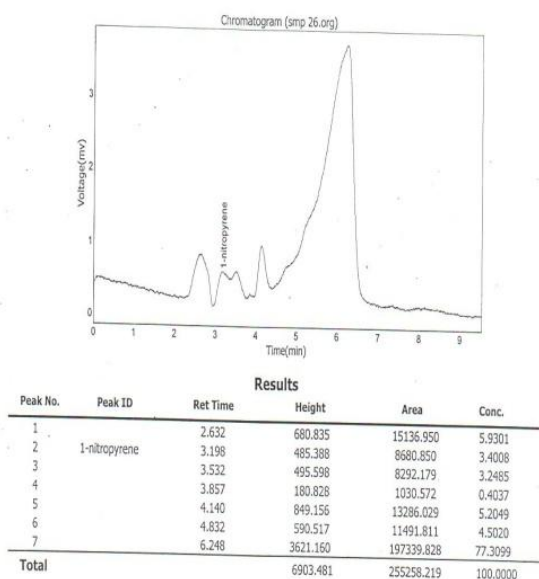
**Chromatogram of Standard:**

This Chromatogram indicates 5 Nitro PAHs: i.e. 1-Nitroanthracene, 2-Nitrofluorene, 9-Nitroanthracene, 3-Nitrofluoranthracene and 1-Nitropyrene. In this standard the concentration of each Nitro-PAH is 10µg/ Liter. Retention times of these Nitro PAHs are:

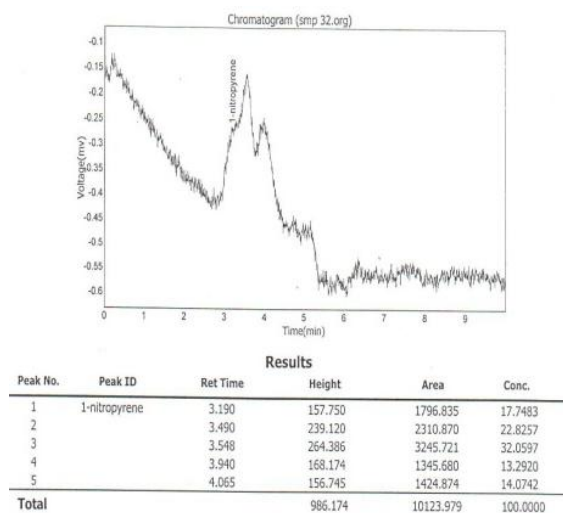
- 1-Nitroanthracene (1.307 min.)
- 2-Nitrofluorene (1.573 min.)
- 9-Nitroanthracene (1.698 min.)
- 3-Nitrofluoranthracene (2.023 min.)
- 1-Nitropyrene (3.057 min.)



**Fig1.** Sample taken from Hattar Industrial area Phase I in which 9-NA was detected at a concentration of 0.41ng/L

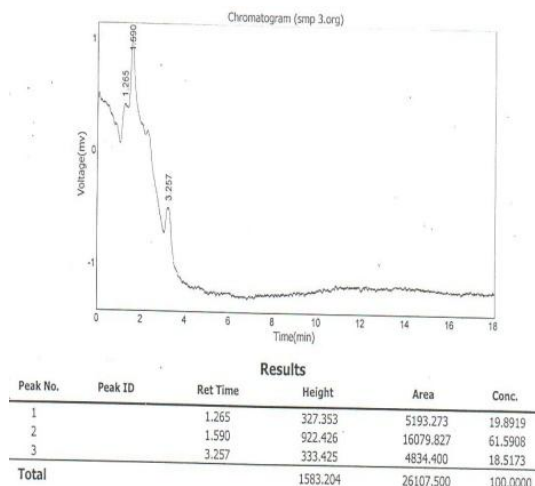


**Fig2:** Sample taken from Hattar Industrial area Phase I in which 1-NP was detected at a concentration of 0.66ng/L

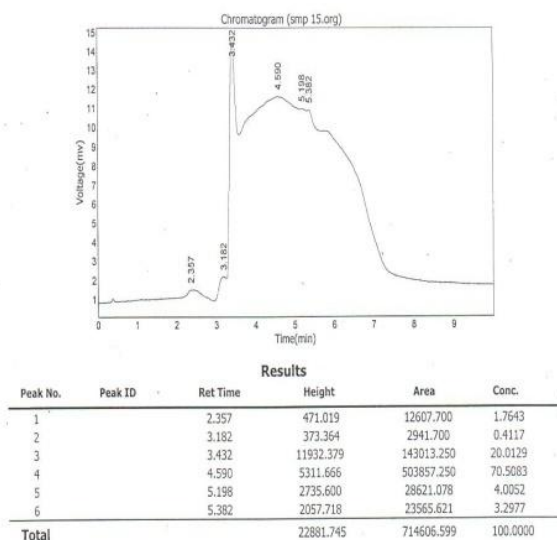


**Fig3:** Sample taken from Hattar Industrial area Phase I in which 1-Nitropyrene was detected at a concentration of 0.21ng/L

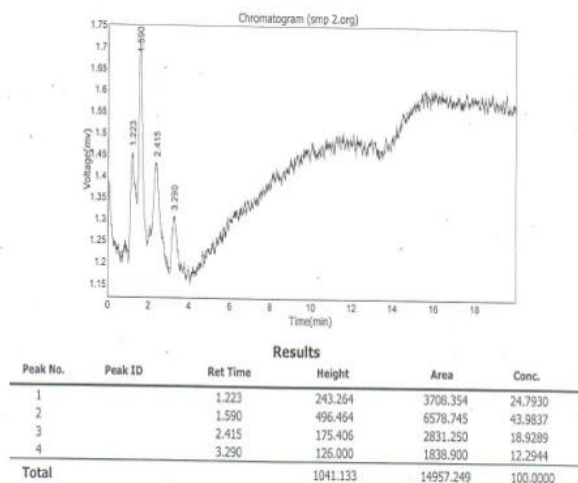
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**Fig4:** Sample taken from Hattar Industrial area Phase I in which 2-Nitrofluorine was detected at a concentration of 0.637ng/L



**Figure 5:** Sample taken from Hattar Industrial area Phase I in which 1-Nitropyrene was detected at a concentration of 0.66ng/L



**Figure 6:** Sample taken from Hattar Industrial area Phase I in which 2-Nitrofluorine was detected at a concentration of 0.34ng/L

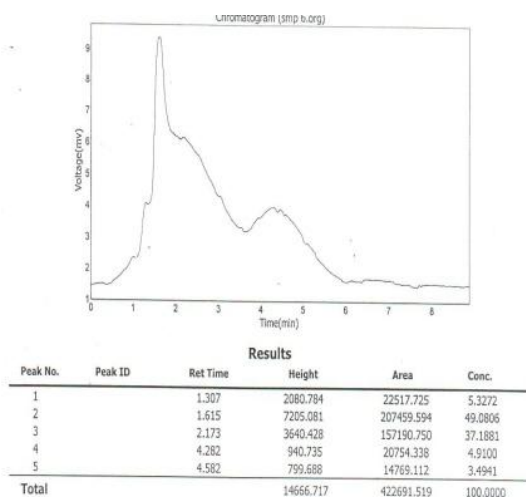
**Sample Taken From Hattar Industrial Estate (Phase IV)**

Samples were collected in the vicinity of Hattar Industrial area Phase IV. In these samples four nitro PAHs were detected because it is industrial area where a number of factories are working including DewanSulemanFibre, Steel Mills and chemicals manufacturing factories. One of the reasons of the presence of Nitro PAHs in water is inadequate sewage system and improper waste disposal of the factories. In Hattar Industrial area Phase IV there are four nitro-PAHs detected. These are: 1-Nitronaphthalene, 2-Nitrofluorine, 9-Nitroanthracene and 1-Nitropyrene.

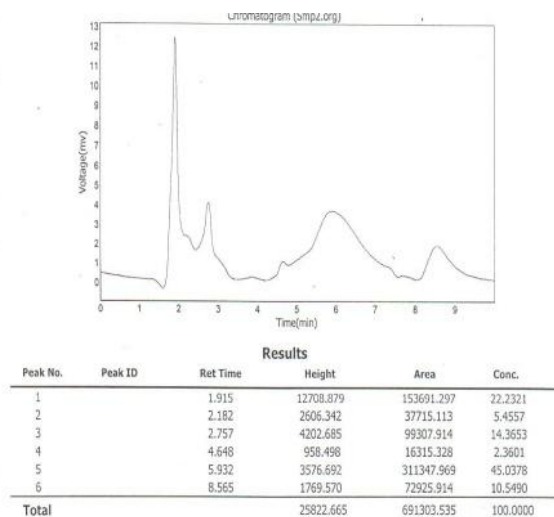
In sample 01, 1-Nitronaphthalene was detected with a concentration of 1.00ng/L. In sample 03 there are three nitro-PAHs detected which are 1-NN, 2-NF, 9-NA with a concentration of 0.69, 0.9 and 0.87 respectively.

**Table 2:** Water sample taken from Hattar Industrial Estate (Phase IV)

Smp. #	Nitro PAHs (ng/ Liter)				
	1-NN	2-NF	9- NA	3-NFA	1- NP
I	1.00	---	---	---	---
II	---	----	----	---	----
III	0.69	0.9	0.87	---	---
IV	---	---	---	---	0.40

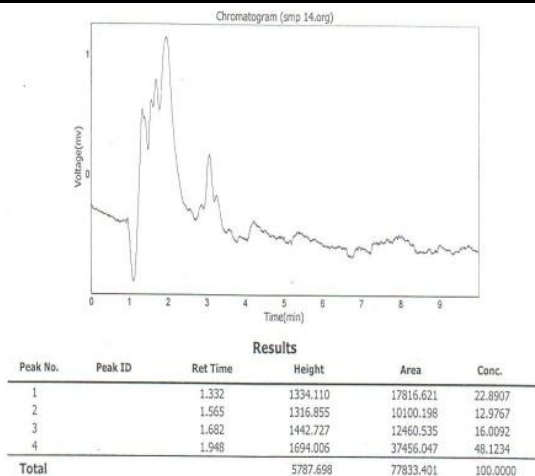


**Fig7:** Sample taken from Hattar Industrial area Phase IV in which 1-Nitronaphthalene was detected at a concentration of 1ng/L

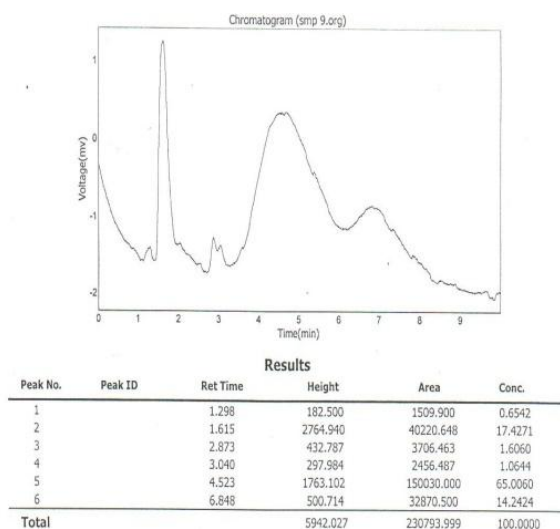


**Fig8:** Sample taken from Hattar Industrial area Phase IV in which 1-Nitronaphthalene was detected at a concentration of 1ng/L

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**Fig9:** Sample taken from Hattar Industrial area Phase IV in which three nitro-PAHs were detected: 1-Nitronaphthalene = 0.69ng/L, 2-Nitrofluorine = 0.90ng/L and 9-Nitroanthracene = 0.87ng/L



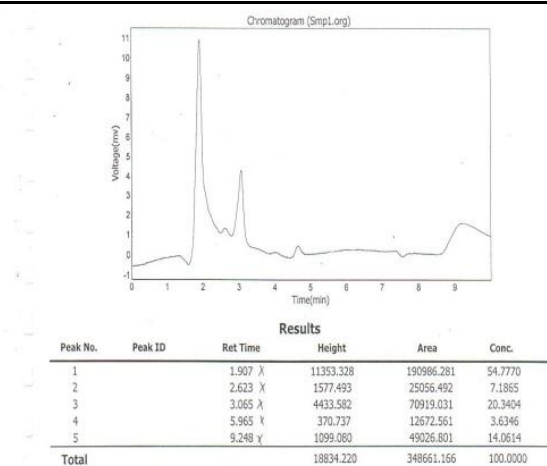
**Fig10:** Sample taken from Hattar Industrial area Phase IV in which 1-Nitropyrene was detected at a concentration of 0.4ng/L

**Samples Taken From Industrial Triangle Kahuta Road Islamabad**

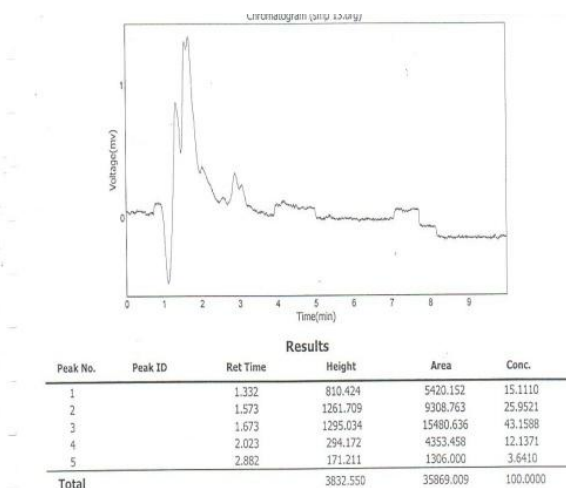
These samples were collected from Industrial Triangle Kahuta Road, Islamabad. In these samples Nitro PAHs are detected as well because this is also industrial area. One of the reasons of the presence of Nitro PAHs in water is inadequate sewage system and improper waste disposal of the factories. Three water samples were collected from Kahuta Industrial estate,. Four Nitro-PAHs are detected in these samples taken from Industrial Triangle Kahuta road. In sample # 01 there was no nitro-PAH detected And in # 02 four Nitro-PAHs were detected which are 1-NN (0.42ng/L), 2-NF (0.87ng/L), 9-NA (0.78ng/L), 3-NFA (0.1ng/L). In sample # 03 2-NF was detected with a concentration of 0.63ng/L.

**Table 3:** Water sample taken from Industrial Triangle Kahuta road Islamabad

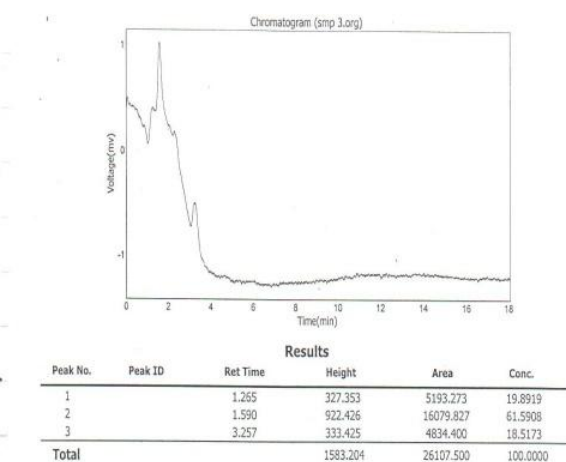
Smp. #	Nitro PAHs (ng/ Liter)				
	1-NN	2-NF	9- NA	3-NFA	1- NP
I	---	---	---	---	---
II	0.42	0.87	0.78	0.1	---
III	---	0.63	---	---	---



**Fig11:** Sample taken from Industrial Triangle Islamabad in which No nitro-PAH was detected.



**Fig12:** Sample taken from Industrial Triangle Islamabad in which 1-NN, 2-NF, 9-NA, and 3-NF was detected.



**Fig13:** Sample taken from Industrial Triangle Islamabad in which 2-NF was detected with a concentration of 0.63ng/L

### Sample Taken From Tip Housing Society, Haripur

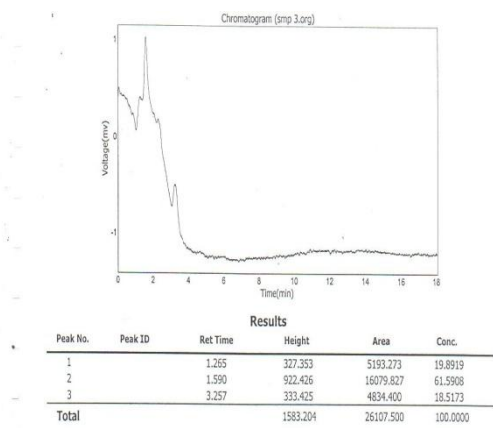
The data about level of PAHs in water samples collected from TIP housing society is given in table 04. The results show that no concentration of PAHs was found in these samples as the area of TIP colony is well planned and environmentally cleaned. Five samples were taken from different sources like tube well, tap water, and these samples were taken from different sectors of society. None of the samples contain any nitro-PAHs. Results are shown in table 04 and chromatograms are shown in figure 22 to 26.



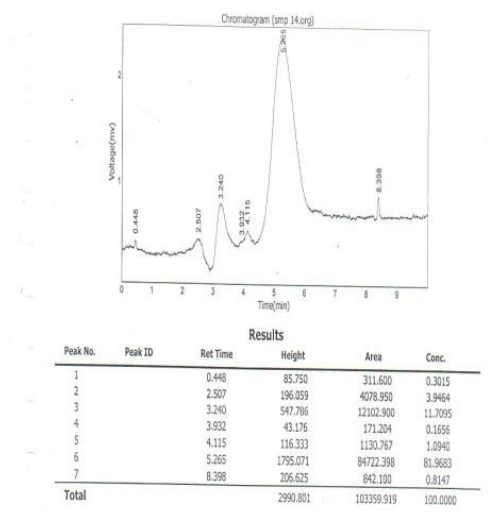
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**Table 4:** Water sample taken from TIP housing society, Haripur.

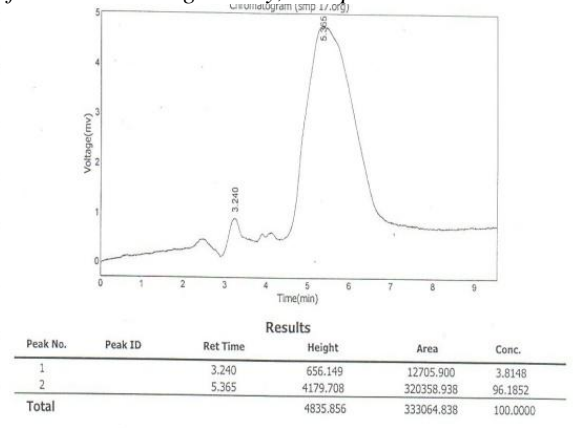
Smp. #	Nitro PAHs (ng/ Liter)				
	1-NN	2-NF	9- NA	3-NFA	1- NP
I	---	---	---	---	---
II	---	---	---	---	---
III	---	---	---	---	---
IV	---	---	---	---	---
V	---	---	---	---	---



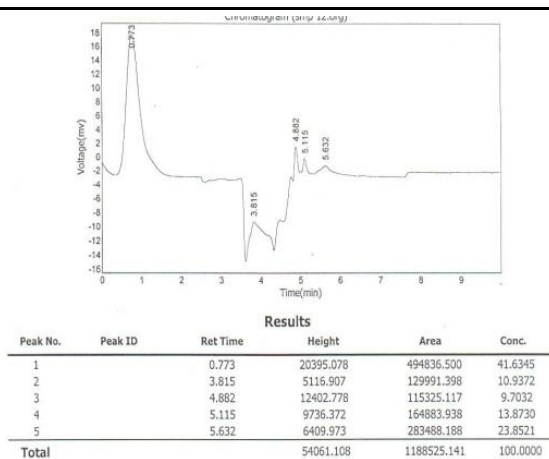
**Figure 14:** Sample taken from TIP housing society, Haripur in which No nitro-PAH was detected



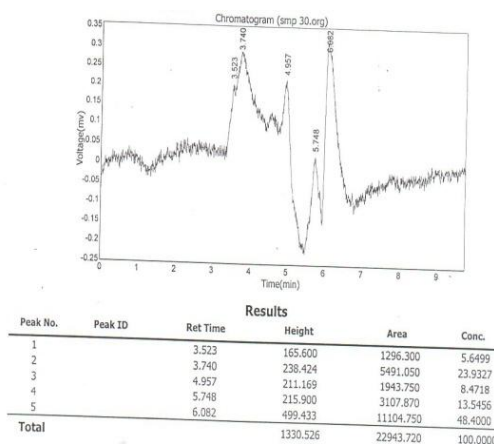
**Fig15:** Sample taken from TIP housing society, Haripur in which No nitro-PAH was detected



**Figure 16:** Sample taken from TIP housing society, Haripur in which No nitro-PAH was detected



**Fig17:** Sample taken from TIP housing society, Haripur in which No nitro-PAH was detected



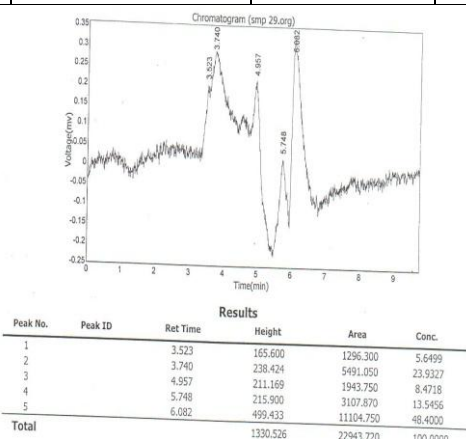
**Fig18:** Sample taken from TIP housing society, Haripur in which No nitro- PAH was detected

**Sample Collected From Bottled Mineral Water**

Table 05 presents the information about PAHs detected in commercially available mineral water sold in plastic bottles with trade names of NESTLE, KINLEY, AQUAFINA and SPARKLY. This data had shown no nitro PAHs were detected in bottled water which means that they have a good source of water and their water treatment is good.

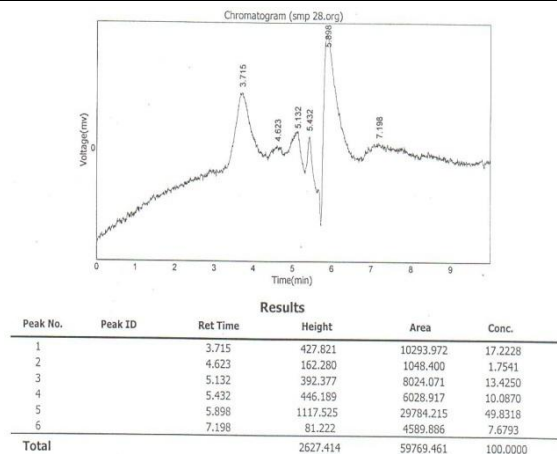
**Table 5:** Water sample taken from Bottles (Nestle, Kinley, Aquafina and Sparkly)

Smp. #	Nitro PAHs (ng/ Liter)				
	1-NN	2-NF	9- NA	3-NFA	1- NP
I	---	---	---	---	---
II	---	---	---	---	---
III	---	---	---	---	---
IV	---	---	---	---	---

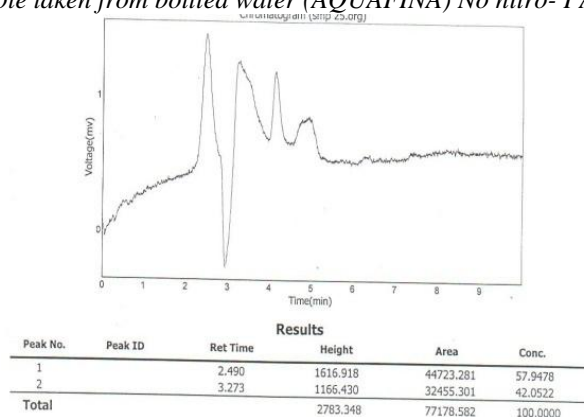


**Fig19:** Sample taken from Bottled water (NESTLE) No nitro- PAH was detected

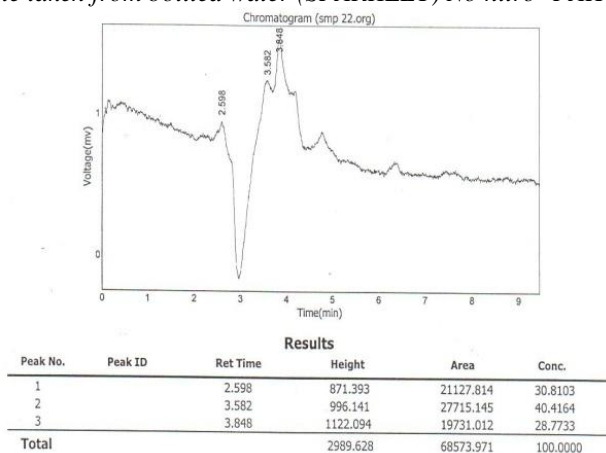
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**Fig20:** Sample taken from bottled water (AQUAFINA) No nitro- PAH was detect



**Fig21:** Sample taken from bottled water (SPARKLEY) No nitro- PAH was detected



**Fig22:** Sample taken from bottled water (KINLEY) No nitro- PAH was detected

**Water Samples Taken From I-9 Industrial Estate Islamabad**

Table 06 presents the data of samples which were taken for analysis from I-9 industrial area, Islamabad, where only one nitro PAH is detected because it is also an industrial area. 9-Nitroanthracene is detected here.

**Table 6:** Water sample taken from I-9 Industrial Estate, Islamabad

Smp. #	Nitro PAHs (ng / Liter)				
	I-NN	2-NF	9- NA	3-NFA	I- NP
I	---	---	---	---	---
II	---	---	---	---	---
III	---	---	0.41	---	---
IV	---	---	---	---	---

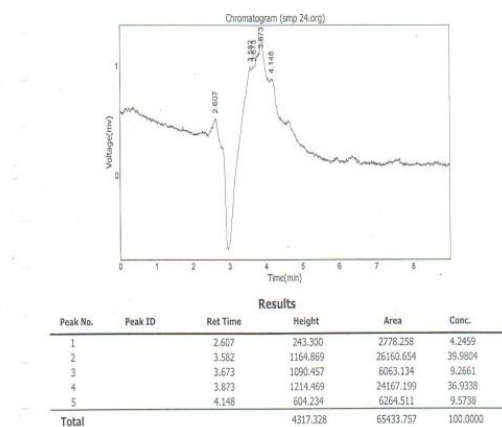


Fig23: Sample taken from I-9 Industrial Estate Islamabad in which No nitro-PAH was detected

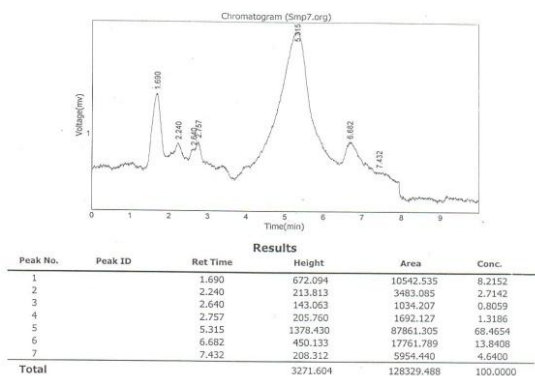


Fig24: Sample taken from I-9 Industrial Estate Islamabad in which No nitro-PAH was detected

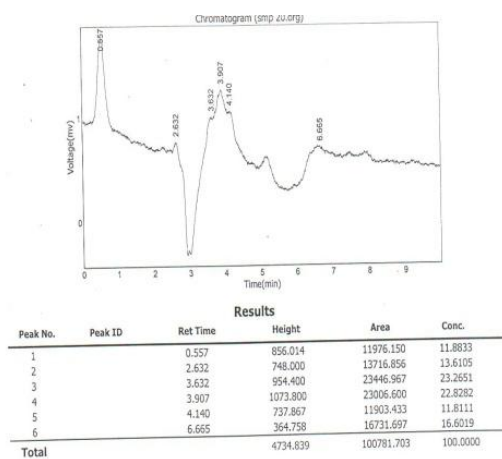


Fig25: Sample taken from I-9 Industrial Estate Islamabad in which 9-NA was detected at a concentration of 0.41ng/L

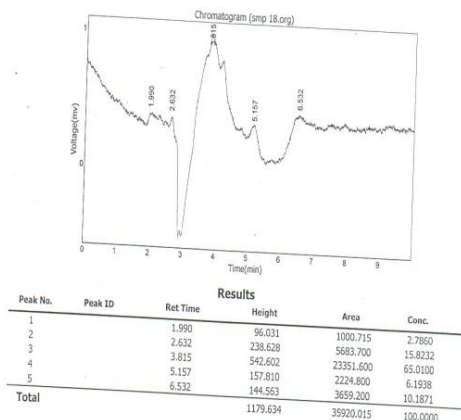


Fig26: Sample taken from I-9 Industrial Estate Islamabad in which No nitro-PAH was detected

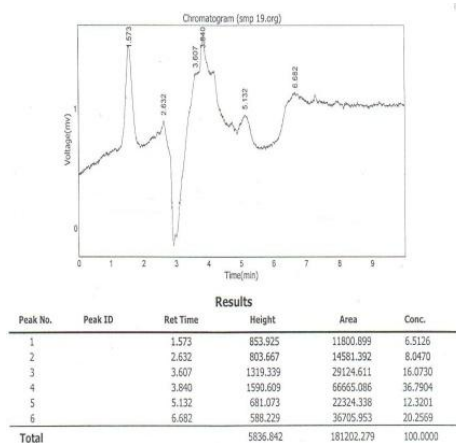
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**Water Samples Taken From Jinnah Abad, Abbottabad**

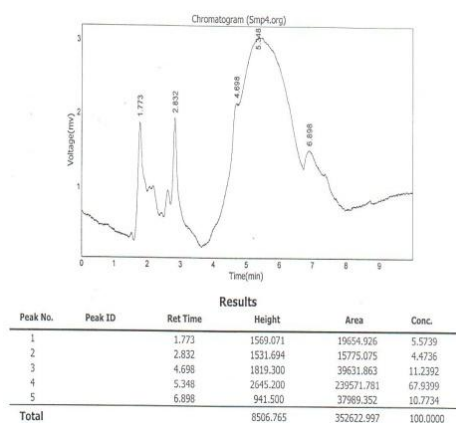
Samples collected from Jinnahabad, Abbottabad are presented in table 7 and their chromatograms are shown in figure 35, 36, 37, 38 and 39 below. No nitro-PAH was detected in any of the samples taken from this vicinity. This was probably because there was no industrial area nearby and also the source of water is very good.

**Table 7:** Water samples taken from Jinnah Abad, Abbottabad

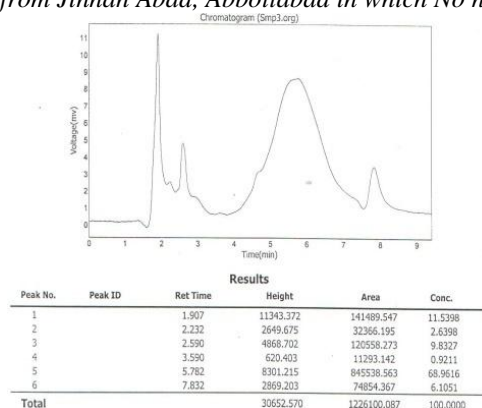
Smp. #	Nitro PAHs (ng/ Liter)				
	1-NN	2-NF	9- NA	3-NFA	1- NP
I	---	---	---	---	---
II	---	---	---	---	---
III	---	---	---	---	---
IV	---	---	---	---	---
V	---	---	---	---	---



**Fig27:** Sample taken from Jinnah Abad, Abbottabad in which No nitro-PAH was detected



**Fig28:** Sample taken from Jinnah Abad, Abbottabad in which No nitro-PAH was detected



**Fig29:** Sample taken from Jinnah Abad, Abbottabad in which No nitro-PAH was detected

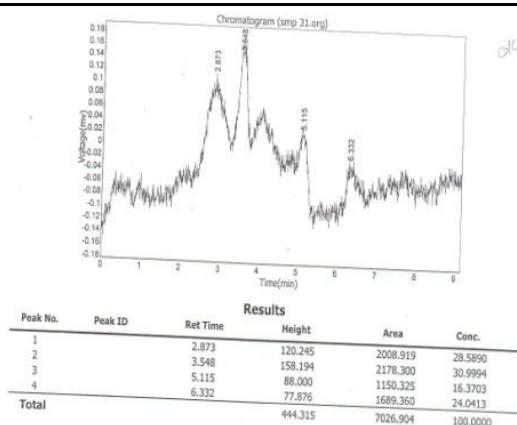


Fig30: Sample taken from Jinnah Abad, Abbottabad in which No nitro-PAH was detected

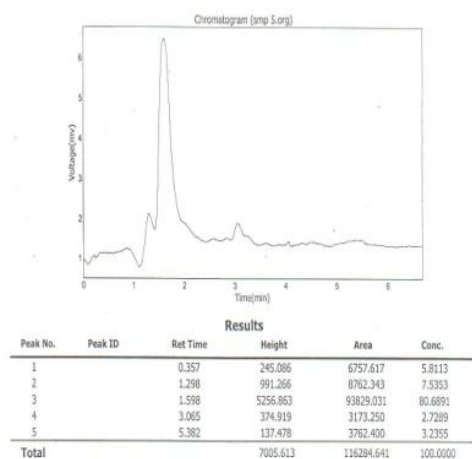


Fig31: Sample taken from Jinnah Abad, Abbottabad in which No nitro-PAH was detected

**Water Sample Taken From Qalanderabad, Abbottabad**

The chromatograms obtained from samples collected from Qalanderabad, Abbottabad are described in table 8 and the chromatograms are presented in figure 40 to 45. No nitro-PAHs were detected because the samples were collected from an area whose water source is of natural springs.

Table 8: Water sample taken from Qalanderabad, Abbottabad

Smp. #	Nitro PAHs (ng/ Liter)				
	1-NN	2-NF	9- NA	3-NFA	1- NP
I	---	---	---	---	---
II	---	---	---	---	---
III	---	---	---	---	---
IV	---	---	---	---	---
V	---	---	---	---	---
VI	---	---	---	---	---

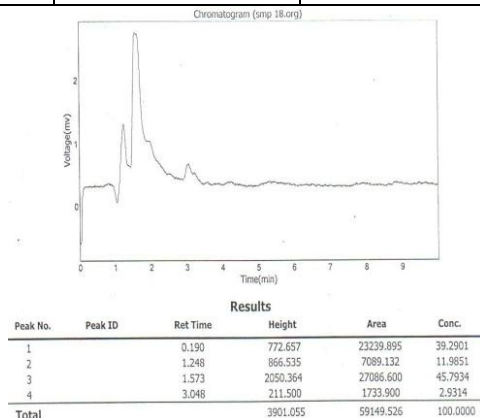
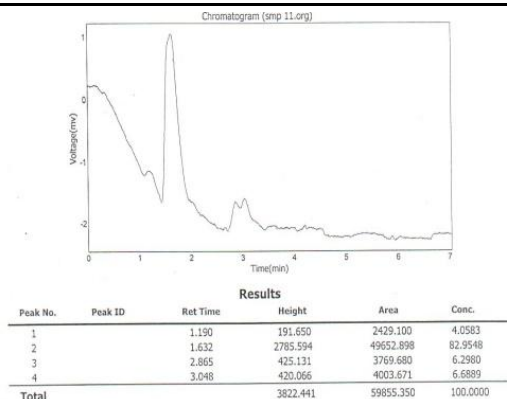
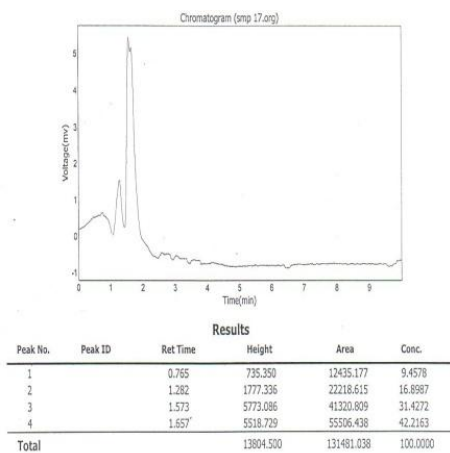


Fig40: Sample taken from Qalanderabad, Abbottabad in which No nitro-PAH was detected

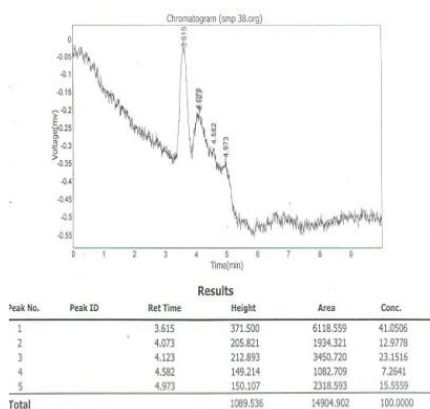
**Comparative Study of Nitrated Aromatic Hydrocarbons in Drinking Water samples taken from Hattar industrial area, TIP housing society, Hazara University Dhodial Mansehra and Kahuta industrial triangle Islamabad, Pakistan**



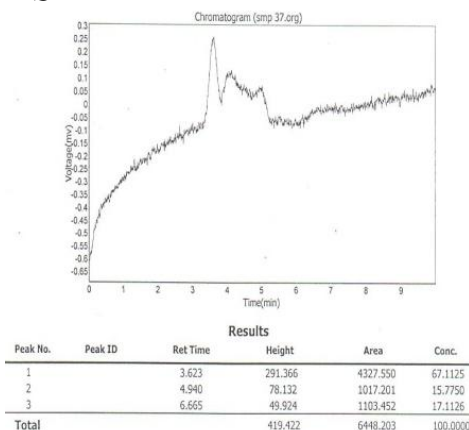
**Fig32:** Sample taken from Qalanderabad, Abbottabad in which No nitro-PAH was detected



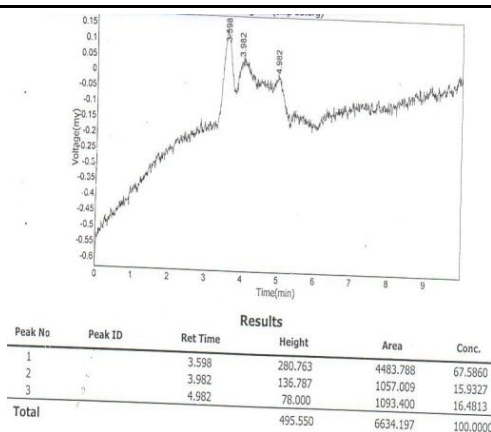
**Fig33:** Sample taken from Qalanderabad, Abbottabad in which No nitro-PAH was detected



**Fig34:** Sample taken from Qalanderabad, Abbottabad in which No nitro-PAH was detected



**Fig35:** Sample taken from Qalanderabad, Abbottabad in which No nitro-PAH was detected



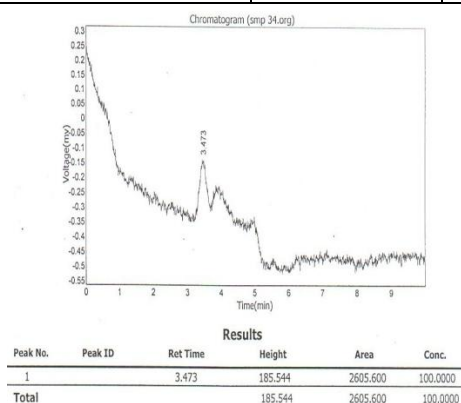
**Fig36:** Sample taken from Qalanderabad, Abbottabad in which No nitro-PAH was detected

**Water Sample Taken From National Industrial Zone Rawat, Islamabad**

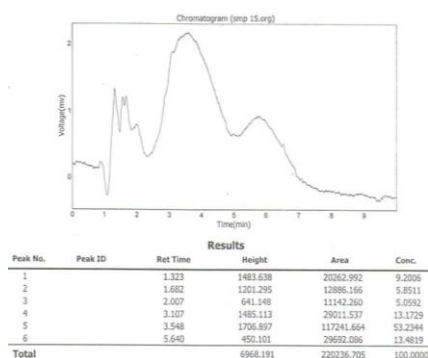
Table 9 shows the list of samples which were collected from National Industrial Zone, Rawat-Islamabad. No nitro-PAH were detected in all these samples as shown in the figure 46 to 52 below. National industrial zone Rawat is a bit planned industrial zone having less industries and a good sewage system. That’s why no nitro-PAHs were detected in the samples collected from NIZ, Rawat, Islamabad. Results are summarized in table 9 and the chromatograms are shown in figures 46 to 52

**Table 9:** Water sample taken from National Industrial Zone Rawat, Islamabad

Smp. #	Nitro PAHs (ng/ Liter)				
	1-NN	2-NF	9- NA	3-NFA	1- NP
I	---	---	---	---	---
II	---	---	---	---	---
III	---	---	---	---	---
IV	---	---	---	---	---
V	---	---	---	---	---
VI	---	---	---	---	---
VII	---	---	---	---	---



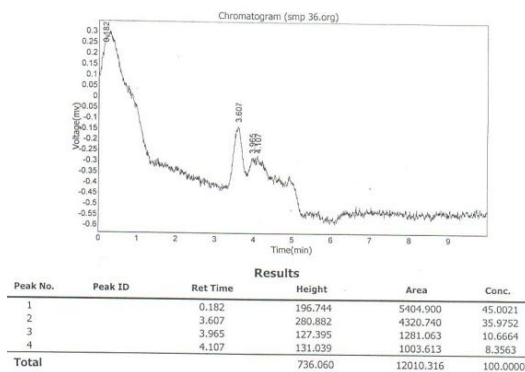
**Fig37:** Sample taken from National Industrial Zone Rawat, in this sample no nitro-PAH was detected



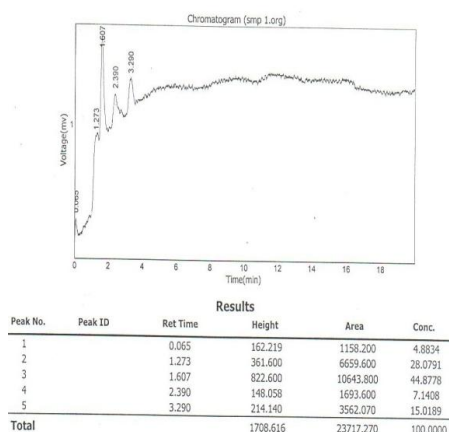
**Fig38:** Sample taken from National Industrial Zone Rawat, no nitro-PAH was detected



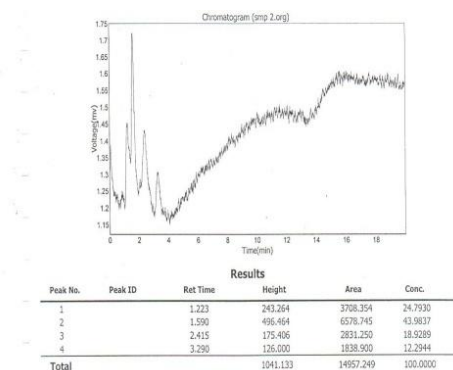
**Comparative Study of Nitrated Aromatic Hydrocarbons in Drinking Water samples taken from Hattar industrial area, TIP housing society, Hazara University Dhodial Mansehra and Kahuta industrial triangle Islamabad, Pakistan**



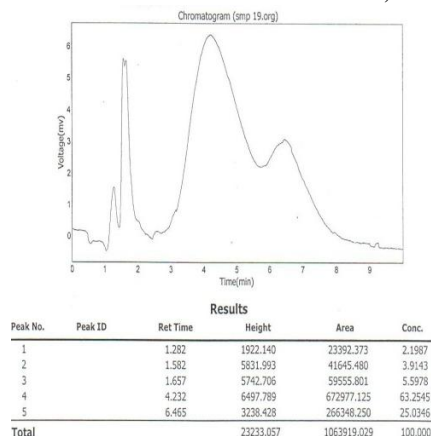
**Fig39:** Sample taken from National Industrial Zone Rawat, no nitro-PAH was detected



**Fig40:** Sample taken from National Industrial Zone Rawat, no nitro-PAH was detected



**Fig41:** Sample taken from National Industrial Zone Rawat, no nitro-PAH was detected



**Fig42:** Sample taken from National Industrial Zone Rawat, no nitro-PAH was detected

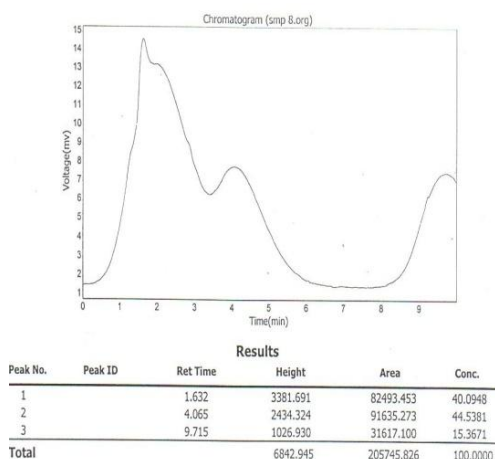


Fig43: Sample taken from National Industrial Zone Rawat, no nitro-PAH was detected

**Water Samples Taken From Dhodial, Mansehra**

Table 10 presents the samples collected from Dhodial, Mansehra. In these samples no nitro-PAH is detected probably because of absence of any industries. Results are described in table 10 while chromatograms are shown in figure 53 to 57.

Smp. #	Nitro PAHs (ng/ Liter)				
	1-NN	2-NF	9- NA	3-NFA	1- NP
I	---	---	---	---	---
II	---	---	---	---	---
III	---	---	---	---	---
IV	---	---	---	---	---
V	---	---	---	---	---
VI	---	---	---	---	---

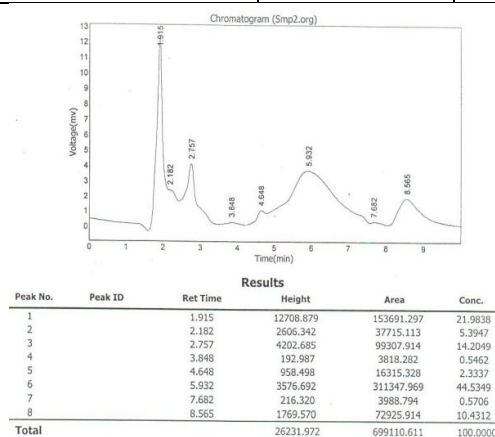


Fig44: Sample taken from Dhodial, Mansehra no nitro-PAH was detected

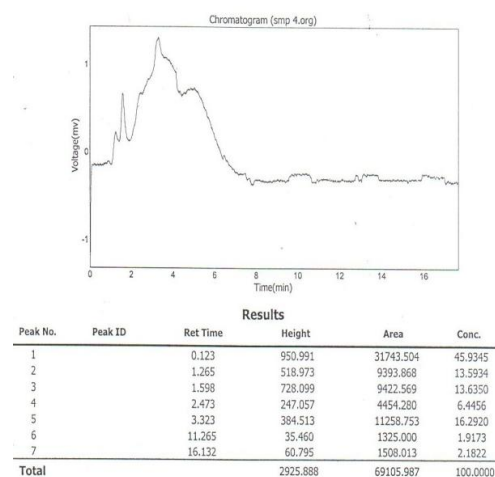
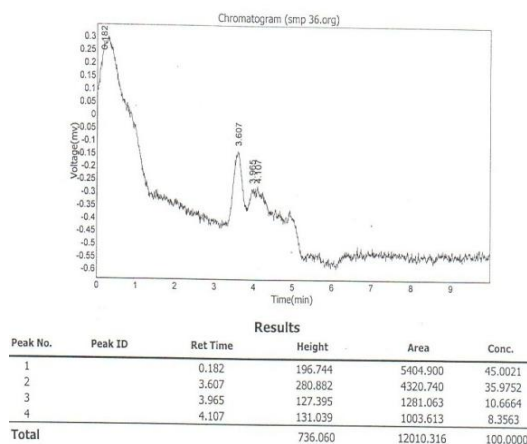
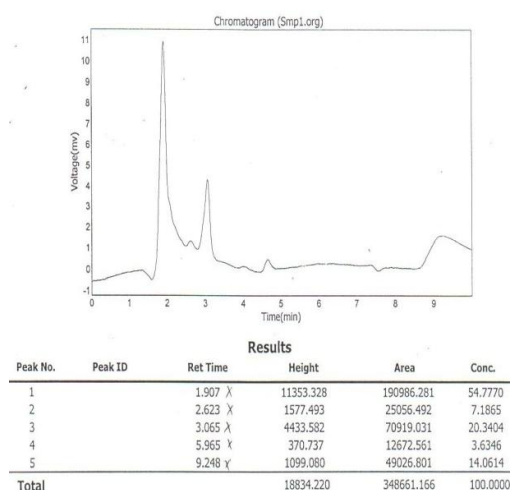


Fig45: Sample taken from Dhodial, Mansehra no nitro-PAH was detected

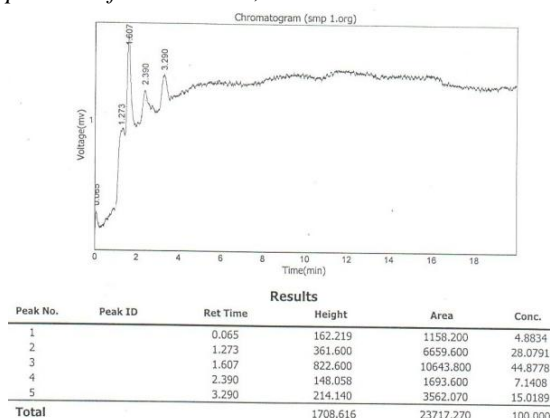
**Comparative Study of Nitrated Aromatic Hydrocarbons in Drinking Water samples taken from Hattar industrial area, TIP housing society, Hazara University Dhodial Mansehra and Kahuta industrial triangle Islamabad, Pakistan**



**Fig55:** Sample taken from Dhodial, Mansehra no nitro-PAH was detected



**Fig46:** Sample taken from Dhodial, Mansehra no nitro-PAH was detected



**Fig47:** Sample taken from Dhodial, Mansehra no nitro-PAH was detected

**4. CONCLUSION**

50 water samples were taken from Hattar industrial area, TIP housing society, Hazara University Dhodial Mansehra and Kahuta industrial triangle Islamabad and analyzed with the help of High Pressure Liquid Chromatography for the determination of 5 Nitro PAHs including: Nitronaphthalene, Nitrofluorine, 9-Nitroanthracene, 3-Nitrofluoroanthene, Nitropyrene. Maximum amount 1ng/L of 1-NN was detected in the water samples of Industrial Estate, Hattar. It is concluded that commercial water supplies are safe for health. The underground water near industrial areas particularly Hattar industrial area is not good for human use. While Rawat Industrial Zone is well planned for water supply and drainage so there no nitro PAHs were detected.

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**Conflict of interest:**

The authors declare that there is no conflict of interest.

**REFERENCES**

- [1] BAXTER, C. V., FAUSCH, K. D., MURAKAMI, M. & CHAPMAN, P. L. 2004. Fish invasion restructures stream and forest food webs by interrupting reciprocal prey subsidies. *Ecology*, 85, 2656-2663
- [2] HUDGINS, D. M., BAUSCHLICHER JR, C. W. & ALLAMANDOLA, L. 2005. Variations in the peak position of the 6.2 $\mu$ m interstellar emission feature: A tracer of N in the interstellar polycyclic aromatic hydrocarbon population. *The Astrophysical Journal*, 632, 316.
- [3] HOOVER, R. 2014. *Need to Track Organic Nano-Particles Across the Universe? NASA's Got an App for That* ". NASA. Retrieved 2014
- [4] MEINERT, C., DE MARCELLUS, P., LE SERGEANT D'HENDECOURT, L., NAHON, L., JONES, N. C., HOFFMANN, S. V., BREDEHÖFT, J. H. & MEIERHENRICH, U. J. 2011. Photochirogenesis: photochemical models on the absolute asymmetric formation of amino acids in interstellar space. *Physics of life reviews*, 8, 307-330.
- [5] SRIVASTAVA, S., SINGH, M., GEORGE, J., BHUI, K., MURARI SAXENA, A. & SHUKLA, Y. 2010. Genotoxic and carcinogenic risks associated with the dietary consumption of repeatedly heated coconut oil. *British journal of nutrition*, 104, 1343-1352.
- [6] YAMAZAKI, H., HATANAKA, N., KIZU, R., HAYAKAWA, K., SHIMADA, N., GUENGERICH, F. P., NAKAJIMA, M. & YOKOI, T. 2000. Bio activation of diesel exhaust particle extracts and their major nitrated polycyclic aromatic hydrocarbon components, 1-nitropyrene and dinitropyrenes, by human cytochromes P450 1A1, 1A2, and 1B1. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, 472, 129-138.
- [7] DUTTA, K., GHOSH, D., NAZMI, A., KUMAWAT, K. L. & BASU, A. 2010. A common carcinogen benzo [a] pyrene causes neuronal death in mouse via microglial activation. *PLoS One*, 5, e9984.
- [8] Yutaka K, Junko S, Takeshi K et al., 2005. Atmospheric polycyclic aromatic hydrocarbons: size distribution, estimation of their risk and their depositions to the human respiratory tract[J]. *Sci Total Environ*, 340: 71–80
- [9] MöllerL, LaxI, ErikssonL. Nitrated polycyclic aromatic hydrocarbons: a risk assessment for the urban citizen. *Environ Health Perspect*. 1993 Oct; 101(Suppl 3): 309–315.
- [10] Bezabeh D, Holly H, Schantz M. Determination of nitrated polycyclic aromatic hydrocarbons in diesel particulate-related standard reference materials by using gas chromatography/mass spectrometry with negative ion chemical ionization[J]. *Anal Bioanal Chem*, 2003. 375: 381– 388.
- [11] JACQUET, M., LAMBERT, V., TODARO, A. & KREMERS, P. 1997. Mitogen-activated lymphocytes: a good model for characterizing lung CYP1A1 inducibility. *European journal of epidemiology*, 13, 177-183.
- [12] DIMASHKI, M., HARRAD, S. & HARRISON, R. M. 2000. Measurements of nitro-PAH in the atmospheres of two cities. *Atmospheric Environment*, 34, 2459-2469.
- [13] Bamford HA, Bezabeh DZ, Schantz S, Wise SA, Baker JE. Determination and comparison of nitrated-polycyclic aromatic hydrocarbons measured in air and diesel particulate reference materials. *Chemosphere*. 2003; 50 (5):575-87.
- [14] Chetwittayachan T, Shimazaki D, Yamamoto K, 2002. A comparison of temporal variation of particle-bound polycyclic aromatic hydrocarbons (pPAHs) concentration in different urban environments: Tokyo, Japan, and Bangkok, Thailand [J]. *Atmos Environ*, 36: 2027–2037.
- [15] Hayakawa K, 2000. Chromatographic methods for carcinogenic/mutagenic nitropolycyclic aromatic hydrocarbons [J]. *Biomed Chromatogr*, 14: 397–405.

- [16] Hayakawa K, Tang N, Akutsu K et al., 2002. Comparison of polycyclic aromatic hydrocarbons and nitropolycyclic aromatic hydrocarbons in airborne particulates collected in downtown and suburban Kanazawa, Japan[J]. *Atmos Environ*, 36: 5535–5541.
- [17] Romero R, Sienna R, Richter P, 2002. Efficient screening method for determination of polycyclic aromatic hydrocarbons (PAHs) in airborne particles. Application in real samples of Santiago-Chile metropolitan urban area[J]. *Atmos Environ*, 36: 2375–2381.