



Concentrations of Monocyclic Aromatics Hydrocarbons: Benzene, toluene, ethylbenzene, and xylene (BTEX) in gasoline samples distributed in Uyo, Niger Delta, Nigeria

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Abstract

Benzene, toluene (methylbenzene), ethylbenzene, and xylene (dimethylbenzene) (BTEX) are volatile organic compounds added to unleaded gasoline to increase octane number, adjust Reid vapor pressures (RVP), British Thermal Unit (BTU) and as anti-knocking agents. BTEX cause several environmental and harmful human health problems. Uyo metropolis is one of the most urbanized cities in Niger Delta impacted by activities of artisanal or illegal oil refining in the Niger Delta Creeks. Also, Nigeria imports most of her petroleum products as a result of inoperability of local refineries. There is therefore need for independent periodic quality check on the petroleum products supplied in the area.

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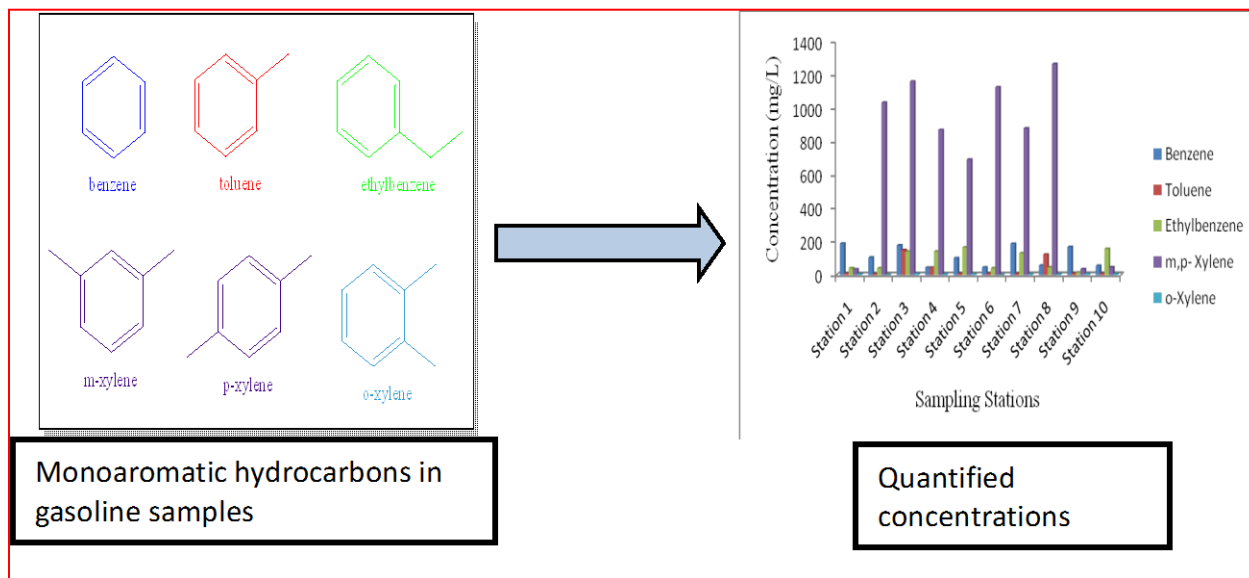
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Hence the aim of this study was to determine the concentrations of BTEX in some gasoline samples distributed in Uyo and compare the concentrations with regional and international standards in respect to human health, environmental concerns and engine efficiency. Gasoline samples from ten (10) different gasoline filling stations were randomly sampled and analyzed for BTEX using Gas Chromatography Flame-Ionization Detection GC-FID through direct injection. The highest and lowest concentrations of benzene were 188.116 mg/L (0.020% by volume) and 44.063 mg/L (0.004 % by volume). The highest and lowest concentrations of toluene were 148.839 mg/L (0.015% by volume) and 2.835 mg/L (<0.001 %). The highest concentrations of ethylbenzene 165.257 mg/L (0.020 %), m, p-Xylene 1264.797 mg/L (0.120 %) and o-Xylene 8.089 mg/L (< 0.001 %) were also recorded. The levels of BTEX in gasoline samples analyzed were within permissible limits (1 % by volume of benzene) and 42 % by volume of toluene, ethylbenzene

and xylene, as recommended by EURO 5 and the African Refiners Association (ARAI 5). There is a need for periodic quality evaluation of gasoline

and other petroleum products circulated in the study area.

Graphical Abstract



Keywords: Concentration; Aromatics; Benzene; Ethylbenzene; Toluene; Xylene

1.0 Introduction

Gasoline is a complex mixture of different hydrocarbons together with other chemical compounds used as fuel for spark-ignition internal combustion engines, primarily in light-duty transportation vehicles (Ricardo *et al.*, 2012). More than 500 different hydrocarbons, together with other additives, are contained in typical gasoline. Gasoline is usually spiked with benzene (C_6H_6), toluene (C_7H_8), ethylbenzene ($C_2H_5C_6H_5$) and (o-, m-, p-) xylenes (C_8H_{10}) (BTEX) (Nelson *et al.*, 2019) as antiknock agents (Barros *et al.*, 2019). The amount of aromatics in gasoline varies between 35% and 40%, with benzene representing 2.500 – 3.000% of the total aromatics (Kerchich *et al.*, 2012). ASTM D5580 - 02 2019 specified 0.140 - 1.790, 2.110 - 10.080 and 0.770-3.920 of benzene, toluene, ethylbenzene and o-xylene, respectively

in finished automotive gasoline. Benzene occurs naturally in crude oil; consequently in gasoline distilled from the crude oil, some quantities are added during the refining process. Benzene concentration in motor gasoline in Europe does not exceed 5% by volume and 3% in Italy (Soleimani, 2020).

Environmental exposure to monoaromatic hydrocarbons (benzene, toluene, ethylbenzene and xylenes) can cause adverse health conditions such as asthma, dizziness, fatigue, and eye, nose, and throat irritations (Kerchich *et al.*, 2012). Benzene is classified as a carcinogen by the International Agency Research of Cancer (IARC) and the American Conference of Governmental Industrial Hygienists (ACGIHs) (Ricardo *et al.*, 2012). Europe, USA, Japan, and Brazil have

specified 1% (v/v) as the maximum permissible concentration of benzene in automotive gasoline (Ricardo *et al.*, 2012; Chattopadhyay *et al.*, 2017). Benzene is the most toxic among BTEX compounds and has been classified as a type 1 carcinogen. Persistent contact with benzene leads to leukemia, in humans (Nelson *et al.*, 2019; IARC, 2018). The replacement of lead by benzene and other aromatics compounds in gasoline has attracted much attention. This is because of an increase in aromatic emissions into the atmosphere (Kerchich *et al.*, 2012).

Toluene is an efficient anti-knock additive in gasoline; it ignites with difficulty at low temperatures, resulting in poor cold start and running characteristics (Ninomiya *et al.*, 2015). Toluene decomposes on combustion forming benzaldehyde and acetylenes as exhaust products (ATSDR, 2017). Exhaust products are directly influenced by fuel composition. Prolonged exposure to xylene and toluene adversely affects the respiratory, central nervous systems, kidney damage and cancer (ATSDR, 2017; ATSDR, 2010). Deaths were reported in Taiwan because of toluene sniffing (Guo, 2015; Fizal, 2018). Studies have indicated that exposure to toluene could result in reproductive toxicity (Demir *et al.*, 2017; Crossin *et al.*, 2018).

Xylene is very reactive compared to other BTEX; it contributes to climate change (Kerchich *et al.*, 2012). Xylene could interrupt the action of proteins necessary for neuron functioning. High concentrations of xylene with prolong exposure could cause severe damage to the lung, kidney, liver and memory impairment (Fizal, 2018; Kandyala, 2010). Exposure of pump attendants to gasoline vapor during vehicle refueling has raised concerns, especially in countries with warmer climates (Hinwooda *et al.*, 2007).

Ethylbenzene is another anti-knock agent in gasoline, prolonged contact with ethyl benzene may produce kidney damage and cancer (ATSDR, 2010). Ethylbenzene is considered an ototoxicant of a group of 21 organic solvents (Kuranchie *et al.*, 2019). High concentration of ambient BTEX fluidity occurs in refilling of gasoline storage tanks at gasoline filling stations in Thailand (Sairat *et al.*, 2015). Gasoline attendants have a high threat of exposure to BTEX through nasal inhalation, dermal absorption, and ingestion (Kuranchie *et al.*, 2019).

There is increase in amount of pollution arising from the concentrated operations of automobile (Sax, 2001, Ekanem *et al.*, 2021). Petroleum hydrocarbons in the environment pose severe health problems to humans and other organisms (udo *et al.*, 2021). Studies have indicated the incidence of more than 600 organic compounds in the environment, mostly polycyclic aromatic hydrocarbons (PAHs), ketones, aldehydes and alcohols from Petroleum hydrocarbons (Gryniewicz *et al.*, 2002, Ekanem *et al.*, 2021). Environmental contamination by hydrocarbons and derivatives has caused the local extinction of many species of plants and animals (Gryniewicz *et al.*, 2002). Several micro-organism in the environment naturally have the enzymatic capability to biodegrade petroleum hydrocarbons, mostly the normal alkanes ranging from C10 - C26, but also including the toxic compounds of low-molecular weight aromatics (BTEX) from petroleum products (Awaka-ama, 2012). Many attempts have been launched to remediate PAHs in crude oil contaminated soils. The persistence, mutagenic and carcinogenic potentials of aromatic hydrocarbons contaminants call for regulation in many countries.

Hoekman (1992) reported that the a standard hydrocarbons composition (% volume) of gasoline includes 4-8% alkanes; 2-5% alkenes;

25-40% isoalkanes; 3-7% cycloalkanes; 1-4 % cycloalkenes; 20-50% aromatics with 0.5-2.5 % benzene. The exact chemical composition of different petroleum fractions differs depending on the source of crude oil, refining practices and the country's specifications. In formulating automotive gasoline to meet efficient engine performance, human and environmental considerations should be of immense concern. This is because high demand for crude oil, petrochemicals and natural gas occasioned by pollution of the environment with consequent human health implications (Nwadinigwe *et al.*, 2014). Refineries in Nigeria produce far below their installed capacity or not producing at all. Consequently, Nigeria imports most of her gasoline; there is therefore a tendency to import adulterated or substandard products for profiteering (Udo *et al.*, 2020, 2023). Also, an increase in population, vehicular and industrial activities in the study area, along with a proportional increase in gasoline demand, should prompt the necessity for regular quality control. There are numerous evidence supporting the harmful impacts of vehicle emissions on human health (Zheng, 2017). Furthermore, there is an increase in reported cases of cancer, respiratory diseases, central nervous disorder and kidney failure in the study area. BTEX even at low concentrations are genotoxic, carcinogenic, ototoxic and neurotoxic. The innovation in this work is highlighted from the fact that from available literature, there is limited or no available database as regard the composition of petroleum products and additives used in the study area. There is need for periodic assessment of the percentage of additives in petroleum products imported or produced in an area, the occupational exposure by workers to these products and its impact on the engine efficiency of these products. Hence the need for determination of concentrations of BTEX in

gasoline distributed in the study area considering the effects of BTEX on environment and human health, and the need to compare the concentrations with regional and international standards is robustly addressed in this work. The aim of this research therefore was to: determine the concentrations of BTEX in some gasoline samples distributed in Uyo Metropolis, Akwa Ibom State, Nigeria and compare the concentrations with regional and international standards with respect to human health and environmental concerns.

2.0 Materials and Method

2.1 Sample collection and instrumentation

Automotive gasoline samples from ten (10) different fuel filling stations (stations 1- 10) in Uyo Metropolis were collected (Fig.1) into airtight amber sample bottles (2.5 L) with a glass stopper. Random sampling method was adopted in collection of the samples. The sample bottles were rinsed with the gasoline sample to be collected at each fuel station. The sample was introduced into the sample bottle via the dispenser nozzle, labeled and transported to the laboratory for treatment and analyses. The concentration of BTEX in the samples was determined using GC-FID through direct injection without further treatment. The GC-FID with a split injector 10:1 and fused silica capillary column (30M x 0.53MM X 0.53 M) was used for the analysis. Oven temperatures were programmed from 100 °C to 300 °C at a fixed rate of 3 °Cmin⁻¹ Horsepower 1 fuse (HP-1). Helium gas was used as a carrier gas at a flow rate of 2ml min⁻¹, the injector and detector temperatures were 300°C and 325°C respectively.

2.2 The Study Area

The Uyo Local Government Area is in Akwa Ibom State, Niger Delta (South South) region of

Nigeria, West Africa (Ibuot *et al.*, 2017; Nse *et al.*, 2020). It lies within 5.03°N and 5.09°N of latitude and 7.41°E and 8.10°E of longitude in the tropical rain forest belt of Nigeria. The study area has a total land mass of 362 km² with a projected population of 5, 482,177 (Figure 1). Uyo is the state capital and the most populated local government area in Akwa Ibom State (Nse *et al.*, 2020). The population status reflects an increase in urbanization with a resultant increase in economic activities such as vehicular activities, which lead to an upsurge of gasoline filling stations. This can impact negatively on the environment and human health. Also, Uyo metropolis is the most urbanized area in Akwa Ibom State with increase in economic activities

and resultant increase in vehicular activities including an upsurge of gasoline filling stations. Also, as a major town in Niger Delta, Uyo is impacted by activities artisanal or illegal oil activities in the Niger Delta Creeks

3.0 Results and Discussion

Automotive gasoline samples distributed in Uyo Metropolis, South-South Nigeria, from ten (10) different fuel stations were analyzed for benzene, toluene, ethylbenzene and xylene (BTEX) using GC-FID. Varying concentrations of BTEX were detected in the different sampling stations. The results are as presented in Tables 1-11 and Figure 2, respectively.

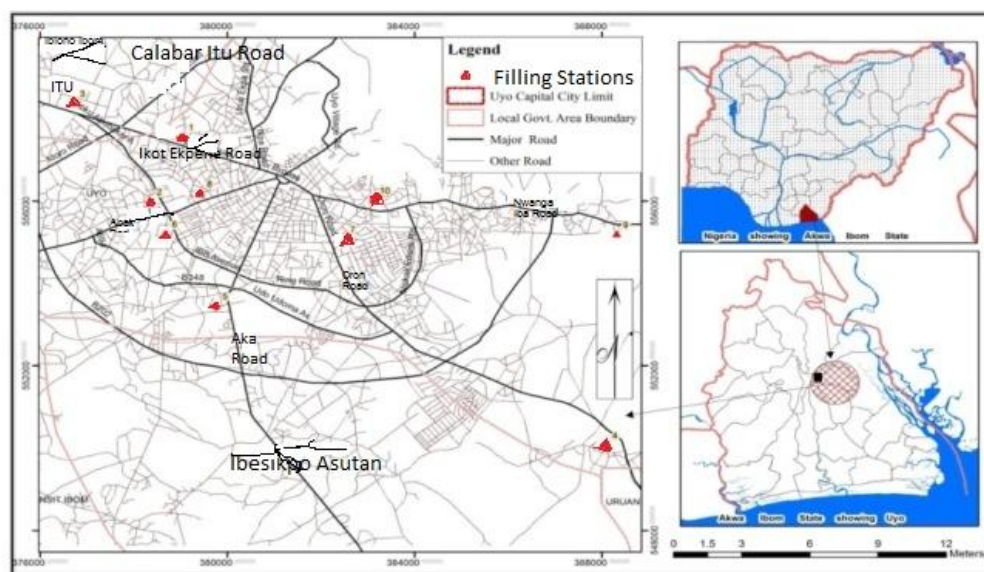


Fig. 1: Map of Uyo Capital City showing the Sampling Stations

Table 1: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from Filling Station 1

Retention Time[Min]	Area pA*s	Amount/Area	Amount [mg/L]	Group Name
3.791	733.812	2.564e-1	188.116	Benzene
5.202	86.743	1.119e-1	9.703	Toluene
6.806	141.243	2.891e-1	40.827	Ethylbenzene
7.077	229.880	1.473e-1	33.861	m,p Xylene
7.776	38.136	1.638e-1	6.247	o-Xylene
Total			278.754	

Table 2: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from Filling Station 2

Retention Time[Min]	Area pA*s	Amount/Area	Amount [mg/L]	Group Name
3.849	408.241	2.560e-1	104.517	Benzene
5.214	52.673	1.119e-1	5.892	Toluene
6.793	140.429	2.890e-1	40.590	Ethylbenzene
7.075	7812.201	1.484e-1	1159.590	m,p Xylene
7.690	11.240	1.465e-1	1.647	o-Xylene
Total			1312.236	

Table 3: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from Filling Station 3

Retention Time[Min]	Area pA*s	Amount/Area	Amount [mg/L]	Group Name
3.854	693.000	2.563e-1	177.636	Benzene
5.134	1330.593	1.118e-1	148.839	Toluene
6.799	51.117	2.858e-1	14.611	Ethylbenzene
7.073	6962.265	1.484e-1	1033.402	m,p Xylene
7.709	48.904	1.654e-1	8.089	o-Xylene
Total			177.636	

Table 4: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from Filling Station 4

Retention Time[Min]	Area pA*s	Amount/Area	Amount [mg/L]	Group Name
3.807	172.805	2.550e-1	44.063	Benzene
5.214	136.167	1.119e-1	15.232	Toluene
6.790	483.156	2.903e-1	140.280	Ethylbenzene
7.044	5859.310	1.484e-1	869.649	m,p Xylene
7.702	30.540	1.620e-1	4.948	o-Xylene
Total			1074.172	

Table 5: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from Filling Station 5

Retention Time[Min]	Area pA*s	Amount/Area	Amount [mg/L]	Group Name
3.845	393.073	2.560e-1	100.623	Benzene
5.213	78.476	1.1186e-1	8.778	Toluene
6.824	569.025	2.904e-1	165.257	Ethylbenzene
7.044	4659.646	1.484e-1	691.538	m,p Xylene
7.696	42.324	1.645e-1	6.964	o-Xylene
Total			973.159	

Table 6: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from Filling Station 6

Retention Time[Min]	Area pA*s	Amount/Area	Amount [mg/L]	Group Name
3.840	177.669	2.5504e-1	45.312	Benzene
5.232	25.343	1.119e-1	2.835	Toluene
6.790	138.850	2.890e-1	40.131	Ethylbenzene
7.073	7581.917	1.484e-1	1125.400	m,p Xylene
7.699	12.264	1.485e-1	1.822	o-Xylene
Total			1215.500	

Table 7: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from Filling Station 7

Retention Time[Min]	Area pA*s	Amount/Area	Amount [mg/L]	Group Name
2.591	845.512	2.453e-1	187.010	Benzene
4.201	66.443	1.618e-1	7.682	Toluene
7.906	121.150	2.225e-1	130.485	Ethylbenzene
6.097	227.779	1.361e-1	878.686	m,p Xylene
8.685	47.136	1.1262e-1	5.343	o-Xylene
Total			1209.206	

Table 8: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from Filling Station 8

Retention Time[Min]	Area pA*s	Amount/Area	Amount [mg/L]	Group Name
4.654	572.780	2.453e-1	56.212	Benzene
4.020	1220.473	2.119e-1	122.749	Toluene
5.687	51.177	1.747e-1	45.727	Ethylbenzene
8.073	7872.276	2.374e-1	1264.797	m,p Xylene
7.600	47.810	1.564e-1	4.410	o-Xylene
Total			1493.895	

Table 9: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from Filling Station 9

Retention Time[Min]	Area pA*s	Amount/Area	Amount [mg/L]	Group Name
2.545	282.09307	2.627e-1	167.364	Benzene
5.012	88.54588	2.119e-1	9.823	Toluene
6.705	678.02728	2.505e-1	15.511	Ethylbenzene
6.022	5899.54661	1.95e-1	34.765	m,p Xylene
7.787	55.42396	1.705e-1	7.892	o-Xylene
Total			235.355	

Table 10: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from Filling Station 10

Retention Time[Min]	Area pA*s	Amount/Area	Amount [mg/L]	Group Name
4.730	167.559	2.440e-1	55.317	Benzene
5.332	37.234	2.108e-1	8.748	Toluene
5.790	149.900	2.990e-1	156.614	Ethylbenzene
7.679	8081.416	1.554e-1	45.772	m,p Xylene
7.579	13.075	1.446e-1	5.998	o-Xylene
Total			272.449	

3.1 Benzene

Highest concentration of benzene of 188.116 mg/L (0.02% by volume) was recorded in Filling Station 1 and as presented in Tables 1, 11 and Figure 2. Also, the lowest concentration of benzene 44.063 mg/L (0.004 % by volume) was recorded in Fuel Station 4 and is presented in Tables 4, 11 and Figure 2, respectively. The concentration of benzene agrees with EURO 2 grade with maximum concentration 43800 mg/L 5 % by volume (Speight, 2015), and African Refiners Index (AFRI-5) 1 % by volume of gasoline (Towards, 2016). In a related study 2.500 % of benzene was recorded in automotive gasoline distributed in Ghana (Kuranchie *et al.*, 2019). BTEX e.g. Benzene is a natural component of both crude oil and petrol but there are also added to unleaded gasoline to increase octane number, adjust Reid vapor pressures (RVP), British Thermal Unit (BTU) and as anti-knocking agents. Typically, the concentration of benzene in these fuels is 1–2% by volume (ATSDR, 2007). Benzene concentration in fuels sold in the European Union must be less than 1.0% by volume (European Commission, 2009). The concentration of benzene in gasoline varies with the refinery process, adulteration and origin of the crude.

The level of benzene in automotive gasoline distributed in Europe varied between 2,628 mg/L and 75,336 mg/L (0.300 to 8.600 % by volume) (Fizal *et al.*, 2019; Zheng *et al.*, 2017).he

concentration of benzene in automotive gasoline from all the filling Stations in this study was within the maximum limits of 43,800 mg/L (5 % by volume) and 8760mg/L (1 % by volume) specified in EURO 5 and ARAI 5 (Fizal *et al.*, 2019; Speight(2015) stated that the concentration of benzene in automotive gasoline varies between 1 and 5 %. The toxicity of benzene is related to leukemia in human (Ebenguela *et al.*, 2021). Continuous, prolonged exposure to benzene could constitute a health risk such as cancer and some respiratory diseases. Contact of benzene by crude oil and petroleum products workers at various works sites is a permanent risk because benzene is a natural constituent of crude oil and used as additive to some petroleum products (Ebenguela *et al.*, 2021). In a related work, it was stated that exposure to the solvents present in gasoline could alter mood, cause depression, cramps, dizziness, drowsiness, headaches, irritability, nervousness and weakness (Barbara *et al.*, 2021).

3.2 Toluene

The findings also revealed the highest concentration of toluene 148.839 mg/L (0.015 by volume) was recorded in Filling Station 3 and the lowest concentration of Toluene 2.835 mg/L was recorded in Filling Station 6 as presented in Tables 3, 6, 11 and Figure 2 respectively. (Syimir *et al.*, 2018) in a related study reported 21,685.680 mg/L (2.690 % by volume) of Toluene in gasoline samples in Malaysia (Fizal *et*

al., 2018). Similarly, Syimire *et al.* (2018) reported 21685.680 mg/L toluene in Malaysian gasoline. The African Refiners Association does not have a specification for toluene in gasoline. Mental health research in the UK recommends 11.400 % Toluene in gasoline (Francis *et al.*, 2019). The elevated level of toluene recorded in Filling Station 3 (Table 3) calls for concern. This is because dementia, ataxia, and various other neurologic deficits can develop in human e.g. petrol pump attendant on prolong exposure to toluene. Cognitive dysfunction is particularly devastating, and the severity of the neurobehavioral deficits. Toluene is classified as a group 3 carcinogen. Gasoline is the main source of exposure to toluene (Soleimani, 2020). Toluene concentrates most in refineries, gas stations and areas with heavy traffic. Toluene may trigger apoptosis and gliosis even in about 3 hours (Demir, 2017). The increase in concentrations of some parameters in some fuel stations sampled could be due to refinery process, adulteration, and origin of the crude.

3.3 Ethylbenzene

The highest concentration of Ethylbenzene 165.257 mg/L (0.02 %) was recorded in fuel Station 5 while the lowest concentration of Ethylbenzene 15.511 mg/L (0.002 %) was recorded in Fuel Station 9 as presented in Tables 5, 9, 11 and Fig. 2, respectively. Ethylbenzene is an additive in gasoline and aviation fuel as an anti-knock agent and adjustment of Reid vapor pressures (RVP). Estimates of ethylbenzene in gasoline have ranged from < 1–2.700%. The 0.200 % (Table 5) and 0.002 % (Table 9) recorded in this study is within therecommended level. Ethylbenzene is ever-present in urban and rural atmospheres, occasioning by vehicle, petroleum and industrial emissions.

3.4 Xylene

The highest concentrations of m, p-Xylene and o-Xylene were 1264.797 mg/L (0.120 %) and 8.089mg/L (< 0.001 %) recorded in Fuel Stations 8 and 3 respectively. Whereas, the lowest concentrations of m, p-Xylene and o-Xylene were 33.86131 (0.003 %) and 1.6468 (< 0.001 %) recorded in fuel Stations 1 and 2 respectively these are as presented in Tables 8, 3, 1, 2, 11 and Figure 1, respectively. ARAI 5 does not have specifications for each of Toluene, Xylene and Ethylbenzene in automobile gasoline; they are classified under aromatics with 42% by volume as the maximum permissible limit (Fizal *et al.*, 2018). In Euro 5, Toluene, ethylbenzene and xylene are categorized under an aromatic group which has a maximum permissible level of 42% by volume (Syimire *et al.*, 2018). The sum of concentrations of Ethylbenzene, m,p Xylene and o-Xylene in each of the fuel Stations from this investigation is presented in Table 11, and were within 42 % by volume as recommended by EURO 5 grade and ARAI-5. Xylene is added to gasoline to increase the British Thermal Unit (BTU) rating and octane. Prolong exposure to xylene can lead nausea, headache, and vomiting, liver and kidney damage, increased blood urea levels, pulmonary congestion, respiratory failure, and hepatomegaly. Continued contact with the skin can cause irritation and dermatitis (Barbara *et al.*, 2021).

Monocyclic aromatic compounds like BTEX are among the ubiquitous and toxic group of anthropogenic pollutants (Bolden *et al.*, 2015). In related study Polycyclic Aromatic Hydrocarbons (PAHs) are widespread in air, water, terrestrial, and biological systems and can be transferred between these resources BTEX even at low concentrations exposure from gasoline, petrochemicals and other industrial solvent can trigger harmful reproductive

development, immunological responses and system toxicity (Sirotkin *et al.*, 2017; Stolark, 2018). A high concentration of benzene exposure leads to aplastic anemia and leukemia (Soleimani, 2020). The higher the amount of BTEX in petrol, the higher the rate of exposure of these contaminants to humans and the

environment (Syimire *et al.*, 2018). About 73% reduction of BTEX is needed for gasoline supply to fall in line with EURO 5 regulation. Immediate regulations are needed to reduce the concentration of BTEX in gasoline (Syimire *et al.*, 2018).

Table 11: Concentration (mg/L) of benzene, toluene, ethylbenzene, m,p-Xylene, o-Xylene from the 10 Filling Stations

Filling Stations	Benzene	Toluene	Ethylbenzene	m,p-Xylene	o-Xylene	Σ of Ethylbenzene, m,p-Xylene, o-Xylene mg/L (%)	
						mg/L	%
Station 1	188.116	9.703	40.827	33.861	6.247	90.638	(0.009)
Station 2	104.517	5.892	40.590	1033.402	1.647	1081.531	(0.11)
Station 3	177.636	148.839	14.611	1159.590	8.089	1331.129	(0.13)
Station 4	44.063	44.063	140.280	869.649	4.948	1058.940	(0.11)
Station 5	100.623	8.778	165.257	691.538	6.964	872.537	(0.09)
Station 6	45.312	2.835	40.131	125.400	1.822	170.188	(0.02)
Station 7	187.010	7.682	130.485	878.686	5.343	1022.196	(0.10)
Station 8	56.212	122.749	45.727	1264.797	4.410	1437.683	(0.14)
Station 9	167.364	9.823	15.511	34.765	7.892	67.991	(0.01)
Station 10	55.317	8.748	156.614	45.772	5.998	217.132	(0.02)
Total	1126.170	369.113	790.032	6137.460	53.36051		

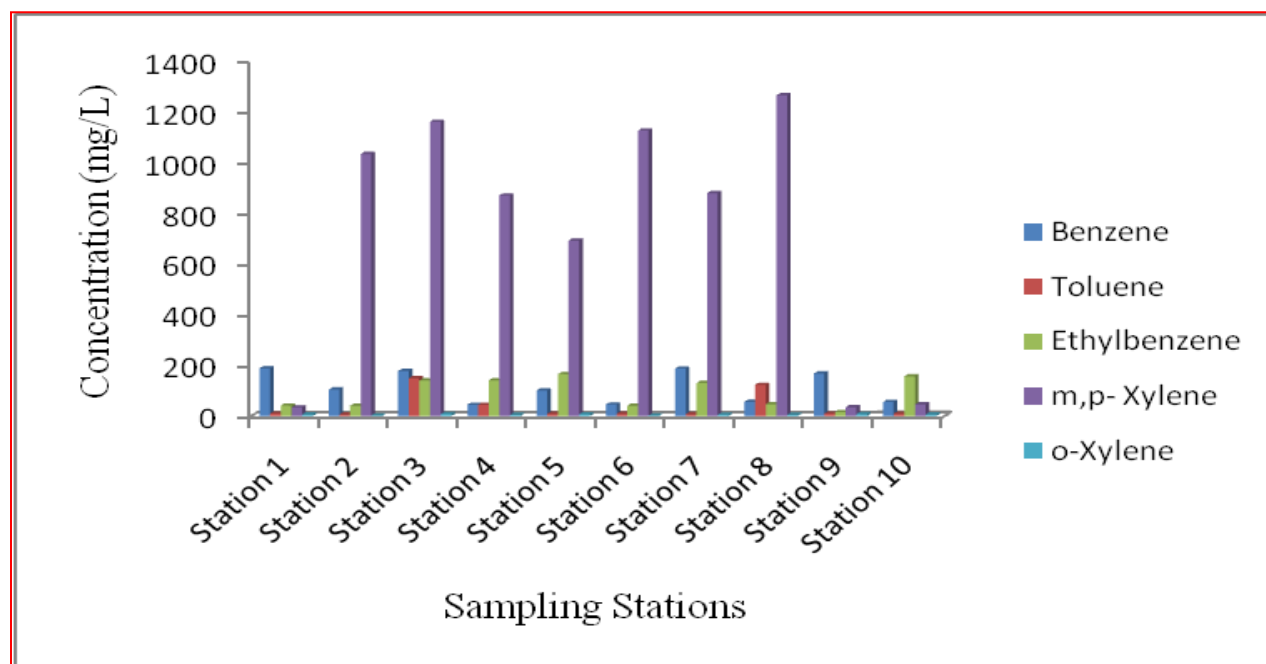


Fig. 2: BTEX concentrations in Sampling Stations 1-10

4.0 Conclusions

The concentrations of BTEX in all the sampling stations were within the permissible limits as specified by ARAI-5 and EURO 5. No fuel sample had elevated concentrations of all the BTEX. These findings revealed that the concentrations of BTEX in gasoline samples distributed in some filling stations in Uyo Metropolis Nigeria may not predispose human health and environment to BTEX toxicity and pollution. Although results of this finding comply with ARAI 5 and EURO 5 standards, there is need for periodic quality evaluation of gasoline and other petroleum products circulated in Nigeria to mitigate human and the environmental exposure. Nigeria should legislate and regulate standards of BTEX in automotive gasoline distributed to reflect regional and international acceptable standards; this will promote engine efficiency and ensure a safe work place.

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Competing Interests

Authors have declared that no competing interests exist.

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