ORIGINAL RESEARCH PAPER

Chemistry

KEY WORDS: VOCs, BTEX, Benzene and Toluene.

BENZENE AND TOLUENE CONCENTRATION AT DIFFERENT TRAFFIC INTERSECTION DURING PRE-MID-POST WINTER SEASON, IN AMBIENT AIR OF ALIGARH AND ITS IMPACT ON HUMAN HEALTH

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ABSTRACT

In current scenario, pollution in environment, is a big problem for all living species at around the world. We know that, Volatile Organic Compounds (VOCs) in presence of sunlight and oxides of nitrogen in atmosphere are considered as precursors for ozone production at the layer of Troposphere. Concentration of Benzene and Toluene (BT) in ambient air was measured near three major traffic sites in the city of Aligarh, India. All air samples were collected using for two times (in a month) during eight hours of normal working period time for in October – December 2020, and January - March 2021. The three selected sites used in this study represent traffic sites (at Etah Chungi Chauraha, Quarsi Chauraha and Sootmil Chauraha, Aligarh). In this study, real-time measurements of Benzene and Toluene concentration were performed the programmable compound specific PID detector designed to provide instantaneous exposure monitoring of a specific organic gas. It monitors a specific gas by utilizing a gas separation tube and the photo-ionization detector (PID) with a 9.8 eV gas discharge lamp (range- 50 ppb to 200 ppb) and whole data analyzed by SPSS software. The study the higher concentration 25.32 µg/m3 of Benzene in the evening shows at site 3 and lower concentration 10.22 µg/m3 of Benzene shows at site 2 in the morning. The higher concentration 22.22 µg/m3 in the evening of Toluene shows at site 1 and lower concentration 07.10 µg/m3 in the evening of Toluene shows at site 2, were observed respectively. Benzene and Toluene were widely used as a solvent in different products and petroleum. Exposure to a mixture of toluene and benzene in air led to an increase in the cytotoxic effect and DNA damage without any further repair and also its chronic effect on human health. The higher concentration of benzene and toluene co-exposure of benzene or toluene in this study. The relevance of these data on interactions for humans exposed at low benzene concentrations can be best assessed only when the mechanism of interaction is understood at a quantitative level and incorporated within a biologically based modelling framework for human health.

INTRODUCTION

We know that, during period of COVID, we had the opportunity to see how taking many cars off of the road and planes out of the skies affected air pollution in the real world in 2019-20. But after unlocking processes of lock-down, all activities again restart. We know from past research that there are pollution disparities based on several factors – most notably race, ethnicity and income – and that communities of colour and lower socioeconomic status face much higher concentrations of benzene and toluene on the traffic sites. Human activity and emissions impacted of VOCs disparities in ambient air of any city in country. In traffic cities of Aligarh, benzene and toluene concentration levels increased at first in the environment. That had a lot to do with the drop in traffic and travel, since vehicle traffic is the largest contributor to release vehicular exhaust in cities. Benzene and Toluene is an important chemical which used as a solvent in industries and petroleum. Benzene is an organic compound (C_6H_6). Benzene is a constituent of crude oil and it's a one of the elementary petrochemicals. Benzene is a colourless and highly flammable liquid and having sweet smell and used as a solvent in gasoline. Benzene most commonly used as an intermediate in the production of other chemicals. Many benzene derivatives, such as styrene and phenol, are used to make a variety of other compounds, such as polymers, plastics, resins, and adhesives. Study shows that human metabolism of benzene to its principal metabolites (ie, hydroquinone, catechol, and phenol) occurs via cytochrome P450 enzyme 2E1 and quinone oxidoreductase NQ01. It is proposed that these metabolites are responsible for much of the systemic toxicity observed after benzene exposure. Benzene affects many organ systems. Specifically, benzene causes bone marrow suppression and, through its metabolites, disruptions in the cell cycle which can lead to mutagenesis.

This effect is further exacerbated by chromosomal aberrations caused by benzene in lymphocytes. As with other solvents, large exposures cause CNS effects.[1] Benzene exposure to the skin causes the development of erythema, burning, and edema. In the gastrointestinal tract, benzene produces a burning sensation of the oral mucous membranes, esophagus, and stomach after ingestion, with associated nausea, vomiting, and abdominal pain. Inhalational exposure causes bronchial irritation, cough, hoarseness, pulmonary edema, and chemical pneumonitis. Exposure to the eyes can cause reversible corneal injury. Chronic toxicity of benzene is usually due to occupational exposure from chronic inhalation. 1) Chronic exposure has resulted in aplastic anemia, acute myeloblastic leukemia, erythroleukemia, and death. Chronic poisoning may occur in employees of gasoline filling stations and bulk gasoline loading facilities because of the high concentration of benzene in gasoline. 2) In chronic poisoning the onset is slow with vague symptoms: fatigue, headache, dizziness, nausea and loss of appetite, loss of weight and weakness are common early complaints. Pallor, nosebleeds, bleeding gums, menorrhagia, petechiae and purpura may develop later. There is great individual variation in the signs and symptoms of chronic benzene poisoning. Long term and high exposure of benzene concentration is responsible for cardiac dysrhythmias.

Toluene is a clear, colourless, volatile liquid under standard conditions. Its odour has been most commonly described as sour or burnt, or sweet and pungent. Toluene is moderately soluble in water and is miscible with most organic solvents. This substance is not corrosive and does not react with dilute acids or bases, but it will react violently with nitric and sulphuric acids (DHSS, 1998; WHO, 1986).

Toluene is not compatible with strong oxidisers such as chlorine, bromine and fluorine (DHSS, 1998). Toluene is a highly flammable liquid and is explosive at room temperature and standard atmospheric pressure. Toluene is a naturally occurring component of crude oil and petroleum (CEPA, 1992). It is isolated from petroleum mixtures by the distillation of reformed or pyrolyzed petroleum and coal-tar oil (ATSDR, 2000). Toluene is a highly toxic chemical that can bring about a wide range of detrimental health effects when inhaled, swallowed, or when it comes into contact with the skin and eyes. According to the *Occupational Safety and Health Administration* (OSHA), the symptoms of acute toluene exposure can include: Cardiac arrhythmia, Confusion, Dermatitis, Dizziness, Euphoria, Exhaustion, Eye and nose

irritation, Headache, Muscle fatigue, Numbness, Weakness. Due to high concentration in the environment, Chronic exposure to toluene, particularly to high levels of this substance, can cause an individual to experience more severe side effects, such as: Ataxia, Cerebral atrophy, Drowsiness, Impaired speech, hearing, and vision, Neurobehavioral changes, Nystagmus and Tremors. Toluene is an acute and long-term environmental hazard that can remain in soil and bodies of water for several days. This substance can linger in aquatic organisms and leave behind long-lasting effects, such as impaired growth. If toluene inhaled, the central nervous system is the body system most at risk from toluene toxicity. Due to high exposure of toluene in the air, can be affected to impair the function of the kidney and liver. In one case, a person who had ingested toluene died following "a severe depression of the [central nervous system]," and showed signs of tubular kidney necrosis and swollen liver. Furthermore, vomiting toluene can place the lungs at risk as doing so can bring about aspiration into the lungs. E. Pariselli and et.al. reported that Human epithelial lung cells (A549) were exposed to toluene and benzene in the air as individual compounds and mixtures at concentrations of about 0.25ppmv in a specifically adapted fumigation device. Possible early toxicological effects at cellular level have been determined by lactate dehydrogenase (LDH), glutathione redox status (GSH) and comet assay.[15-23] An hour of exposure to 0.25ppmv of toluene in the air induced DNA damages which were repaired within 24h after the treatment. No DNA damage was detected by applying a similar concentration of benzene, but there was a decrease in the glutathione ratio. In pregnant women should avoid inhalation of toluene as much as possible because breathing in high levels of Toluene can cause children to develop mental disabilities, minor craniofacial and limb anomalies, and central nervous system dysfunctions while still in the womb. Moreover, the *United States Environmental Protection Agency* (EPA) has noted that children who were born to habitual toluene abusers had signs of temporary renal tubular acidosis, a condition wherein acid accumulates in the body due to the kidney's inability to properly acidify urine.[1-13] Toluene is an acute and long-term environmental hazard that can remain in soil and bodies of water for several days. Toluene is often utilized in the creation of such chemicals as benzene and benzoic acid. Moreover, Toluene used as a solvent in different products such as Adhesives and glues, Aviation fuel, Cleaners, Dyes as hair dyes, Explosives, Gasoline, Inks, Lacquers, Nail treatments and nail polishes, Paints, Resins.[24-27]

In this study, the purpose is that, the exposure to toluene and benzene concentration at traffic site of Aligarh City. Three traffic sites from different regions of Aligarh City were selected and monitored for ambient benzene and toluene concentration in the air. This study could help to our society and aware to government for better life and healthy environment to our society.

METHOD AND MATERIALS

In order to assess the Benzene and Toluene concentration in the ambient air across the Aligarh City was completed. The sampling sites were chosen because ambient benzene and toluene concentration levels were expected to be different at the selected three sites at Etah Chungi Chauraha, Quarsi Chauraha and Sootmil Chauraha, Aligarh. All air samples were collected using for two times (in a month) during eight hours of normal working period time for in October – December 2020, and January - March 2021.

Study Site

Benzene and Toluene were sampled in a different traffic area in Aligarh, Uttar Pradesh, India. The sampling was conducted in the heavy traffic places in the Aligarh City. Samples were collected for two times (in a month) during eight hours of normal working period time for in October - December 2020, and January - March 2021.

Benzene and Toluene Measurement

In this study, real-time measurements of Benzene and Toluene concentration were performed the programmable compound specific PID detector designed to provide instantaneous exposure monitoring of a specific organic gas. It monitors a specific gas by utilizing a gas separation tube and the photo-ionization detector (PID) with a 9.8 eV gas discharge lamp (range- 50 ppb to 200 ppb) and whole data analysed by SPSS software.

Sampling Period

The sampling was done continuously on an eight hours two times in a month for period of six months: October - December 2020, and January - March 2021, which represents the pre-mid-post season of the winter in year.

Sampling Duration

The samples were collected 8 hours continuously 2 times in October - December 2020, and January - March 2021 months.

Statistical Analysis

In this study, the all samples were analysed by SPSS(Version 29), also known as IBM SPSS Statistics. SPSS assist complex data analysis. It provides descriptive, statistics, including methodologies and descriptive ratio statics and also provide bivariate statistics, including ANOVA, means, correlation and nonparametric tests. An analysis of variance (ANOVA) was undertaken for the identification of statistically significant difference (LSD) calculation at an alpha level of 0.05 (= 0.05) and correlation was applied identification among Benzene, Toluene and sites.

RESULTS AND DISCUSSION

The results of Benzene and Toluene in ambient air of Aligarh City at the three selected traffic site. The mean concentration of Benzene at the site1 higher/lower (ranging from 23.67 $\mu g/m^3$ in the evening/11.23$\mu g/m^3$in the morning) and the mean concentration of Toluene at the site1 higher/lower (ranging from 22.22 $\mu g/m^3$ in the evening /09.00$\mu g/m^3$ in the morning). The mean concentration of Benzene at the site 2 higher/lower (ranging from 19.22 $\mu g/m^3$ in the morning /10.22$\mu g/m^3$ in the morning) and the mean concentration of Toluene at the site 2 higher/lower (ranging from17.78 $\mu g/m^3$ /07.10 $\mu g/m^3$ $\mu g/m^3$) in the evening. The mean concentration of Benzene at the site 3 higher/lower (ranging from 25.32 $\mu g/m^3$ in the evening /14.12$\mu g/m^3$ in the morning) and the mean concentration of Toluene at the site 3 higher/lower (ranging from 22.02 $\mu g/m^3$ in the evening/12.12 $\mu g/m^3$ $\mu g/m^3$ in the morning were observed respectively. From the table 1, the higher concentration 25.32 $\mu g/m^3$ of Benzene in the evening shows at site 3 and lower concentration 10.22 $\mu g/m^3$ of Benzene shows at site 2 in the morning. The higher concentration 22.22 $\mu g/m^3$ in the evening of Toluene shows at site 1 and lower concentration 07.10 $\mu g/m^3$ in the evening of Toluene shows at site 2, were observed respectively.

From table 2 and 3; descriptive studies and test of homogeneity, variances of benzene and Toluene compounds shows the significant results at all three selected traffic sites. Benzene and Toluene shows the higher concentration at site 3, Benzene and Toluene shows lower concentration at site 2.

From the table 4; illustrates the variability of Benzene and Toluene concentration over six months, monitored in a high traffic crossroad in Aligarh City, India. The results of Benzene and Toluene concentration of the one-way ANOVA show that there is a statistically significant during the six months; pre-mid-post of the winter season. In the case of Benzene and Toluene concentration were drop in pre and post winter season (Oct-Nov.2020 – Feb.-March2021). The highest Benzene and Toluene levels were found in mid-season of winter at all three selected traffic sites (during Dec.2020 – Jan.2021). The α values of benzene and Toluene >0.05 were found at all three selected traffic sites in an ambient air of the

Aligarh City, India. The variation in concentration of Benzene and Toluene, were also depended on the wind flow rate condition.

In over to the health effects for inhabitants exposed, the chronic effect of Benzene and Toluene compounds in daily intake values were evaluated. Chronic daily intake (CDI) hazard quotient (HQ) and lifetime cancer risk (LTCR) of Benzene and Toluene were obtained in an ambient air of Aligarh City, India. Cancer Risk studies reported by Corina and et. al. in 2021.

The six months variation at all three-traffic site indicate a higher concentration of Benzene and Toluene during mid - season of winter because pollutants were more homogenously distributed in winter season (specially in mid-winter), this variation was also influenced by emission sources and change in the emission activity, removal dispersion / dilution / transport. D. Majumdar[14] and et. al. reported in his study that variation in sources strength and availability of OH radical were identified to be controlling factors. The concentration of Benzene and Toluene were found to be quite high in an ambient air of Aligarh City and their concentration level could be harmful and carcinogenic to the health of the Aligarh City, India.

CONCLUSION

A six months dataset of atmospheric concentration of Benzene and Toluene in the ambient air of all three busiest traffic sites in Aligarh city, U.P. India, was shows in order to observe the implications for human health of the city. The temporal variation of Benzene and Toluene concentrations showed a higher concentration in mid-winter than pre and post winter season. P. Corina and et. al. reported (2021)[27] that chronic effect and 'probable cancer risk' in winter season for humans' health. The present study shows the importance of Benzene and Toluene determination in ambient air of Aligarh city with several activity such as industrial, commercial and heavy traffic (specially at vehicular activity at busiest traffic sites) where many old vehicles are used by citizens. In several studies are reported this kind of problem and could be control the emission sources of pollutants which increased concentrations in ambient air of city because those responsible for hazards of human's health which shown in table 1.

Table 1: Concentration of Benzene and Toluene at different Traffic sites

S. N.	Name of the Sample Site	Time (in yeae)	Average concentration of Benzene µg/m3 M	E	Average concentration of Toluene µg/m3 M	E
Site 1	Etah Chungi Chauraha, Aligarh	Oct. 2020	11.23	11.99	09.00	09.78
		Nov. 2020	12.11	13.01	11.21	12.01
		Dec. 2020	17.47	18.10	14.22	14.22
		Jan. 2021	21.22	23.67	20.13	22.22
		Feb. 2021	22.21	22.34	20.99	21.27
		March 2021	15.43	17.23	14.99	15.33
Site 2	Quarsi Chauraha, Aligarh	Oct. 2020	10.22	11.00	07.12	07.10
		Nov. 2020	10.48	11.01	11.21	12.00
		Dec. 2020	13.32	13.10	12.20	12.18
		Jan. 2021	19.22	18.01	17.11	17.78
		Feb. 2021	18.44	18.99	17.09	17.27
		March 2021	13.40	13.23	11.29	12.12
Site 3	Sootmil Chauraha, Aligarh	Oct. 2020	14.12	14.23	12.12	13.01
		Nov. 2020	18.20	19.99	15.43	15.88
		Dec. 2020	24.57	25.32	21.66	22.02
		Jan. 2021	23.78	23.99	20.02	20.87
		Feb. 2021	23.02	22.02	18.12	18.99
		March 2021	19.34	20.00	17.22	18.02

Table 2: Descriptive Statistics

		Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Benzene µg/m3 (Morning)	Etah Chungi Chauraha, Aligarh	16.612	4.559	1.861	11.827	21.396
	Quarsi Chauraha, Aligarh	14.180	3.854	1.573	10.135	18.225
	Sootmil Chauraha, Aligarh	20.505	4.025	1.643	16.281	24.729
	Total	17.099	4.736	1.116	14.744	19.454
Benzene µg/m3 (Evening)	Etah Chungi Chauraha, Aligarh	17.723	4.736	1.933	12.753	22.694
	Quarsi Chauraha, Aligarh	14.223	3.465	1.415	10.587	17.859
	Sootmil Chauraha, Aligarh	20.925	3.911	1.596	16.821	25.029
	Total	17.624	4.749	1.119	15.262	19.986
Toluene µg/m3 (Morning)	Etah Chungi Chauraha, Aligarh	15.090	4.756	1.942	10.098	20.082
	Quarsi Chauraha, Aligarh	12.670	3.855	1.574	8.624	16.716
	Sootmil Chauraha, Aligarh	17.428	3.386	1.382	13.875	20.982
	Total	15.063	4.289	1.011	12.930	17.196
Toluene µg/m3 (Evening)	Etah Chungi Chauraha, Aligarh	15.805	4.989	2.037	10.569	21.041
	Quarsi Chauraha, Aligarh	13.075	3.957	1.616	8.922	17.228
	Sootmil Chauraha, Aligarh	18.132	3.307	1.350	14.662	21.602
	Total	15.671	4.435	1.045	13.465	17.876

Table 3: Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Benzene µg/m3 (Morning)	.148	2	15	.864
Benzene µg/m3 (Evening)	.266	2	15	.770
Toluene µg/m3 (Morning)	.397	2	15	.679
Toluene µg/m3 (Evening)	.688	2	15	.518

Table 4: Test ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Benzene µg/m3 (Morning)	Between Groups	122.153	2	61.077	3.534	.055
	Within Groups	259.221	15	17.281		
	Total	381.374	17			
Benzene µg/m3 (Evening)	Between Groups	134.826	2	67.413	4.067	.039
	Within Groups	248.634	15	16.576		
	Total	383.460	17			
Toluene µg/m3 (Morning)	Between Groups	67.932	2	33.966	2.082	.159
	Within Groups	244.748	15	16.317		
	Total	312.680	17			
Toluene µg/m3 (Evening)	Between Groups	76.872	2	38.436	2.240	.141
	Within Groups	257.432	15	17.162		
	Total	334.304	17			

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