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Research Article

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Total Volatile Organic Compounds (TVOCs) status in Urban and Suburban area during the summer season in Bilaspur (Chhattisgarh)

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Abstract: Urban and Suburban ambient air concentrations of Total Volatile Organic Compound (TVOC) were measured in Bilaspur city (Urban), Ratanpur (Suburban) and GuruGhasidasVishwavidyalaya (GGV, control), in Chhattisgarh.Bilaspur city was selected as a case study to assess the ambient air quality of TVOC specially released from the motor vehicle at the roadside.The spatial distribution during summer as well as correlation of TVOC at four sites in urban, suburban and control site at GGV campus were analysed. The TVOC analyzer (Phochech Tiger), Ion Science U.K. was used to analyse the concentration of TVOC at each site of the study area. The result show higher variation in TVOC concentration at urban, suburban (roadside) and GGV campus which is rich in greenery and having less vehicular load. The maximum TVOC has been observed at the site U4 144±5.8 ppb (near railway station). This is due to heavy vehicular load emission of semioxidised fuel.Through the study, low concentration of TVOC was found at a control site where low vehicular load and highest at urban areas.

Keywords: Urban, Suburban, TVOC, ambient air, motor vehicle, summer season.

INTRODUCTION

The ambient air quality of cities become increasingly deteriorated worldwide and people were concerned about their health. Air quality monitoring has extended beyond the criteria pollution (carbon monoxide, sulphur dioxide, oxide of nitrogen, ozone and particulate matter) to include measurement of some toxic air pollutants (TAPs) such as volatile organic compounds (VOCs).VOCs are carbon-based compounds that have vapour pressure to significantly vaporise and enter the atmosphere. Generally, VOCsare emitted from natural and anthropogenic sources. The major anthropogenic sources of VOCs are industrial processes, oil refining and from the vehicle. The use of solvents containing products and industrialized and agricultural sources[1].VOCs are an important class of air pollutants commonly found in the urban and industrial atmosphere[2]. Traffic and its related sources are known to be a major source of non-methane hydrocarbons (NMHCs i.e., alkenes, alkynes and aromatic HCs) in urban areas[3-4] but in an industrial and residential area, other sources may also be important.In urban areas, a group of aromatic VOCs (benzene, toluene, ethylbenzene and xylenes) collectively called BTEX to constitute up to 60% of non-methane VOCs[5]. Materials like paints, varnish, waxes, cleaning supplies and adhesive used in building construction also emit the VOCs.Once VOCs are emitted into the atmosphere, they cause not only pollution problem on a local scale but also play an important role on a regional scale like acid rain, photochemical ozone formation initiated by the reaction with OH radicals in the troposphere in the presence of nitrogen oxides and sunlight[6]. In VOCs, which are the main group of hydrocarbons in the atmosphere, play an important role in the formation of ozone and other photochemical oxidants inthe troposphere[7].The short term adverse effects include conjunctive irritation, nose and throat discomfort, headache and sleeplessness, allergic skin reaction, nausea, fatigue and dizziness. While, long term adverse effect includes loss of coordination, leukaemia, anaemia, cancer and damage to the liver, kidney and central nervous system[8-9].

The monitoring of TVOCs at different sites helps to layout preventive measure to protect human health from the effects of a higher concentration of TVOCs. Therefore, the present study has been taken to measure the concentration of TVOCs at a different site in Bilaspur city (Urban), Ratanpur (Suburban) and GGV campus (control site) which is rich with and less vehicular load.

MATERIAL AND METHODS

Bilaspur (urban site) is situated at the latitude-22.0796° N and longitude-82.1391° E with elevation 262 m. The latitude of Ratanpur (suburban site) is-22.2812° N and longitude-82.1550° E andGuru GhasidasVishwavidyalay is situated at the latitude-22.1293° N and longitude-82.1360° E, in Bilaspur district of Chhattisgarh State. The Vishwavidyalayacampus is spread over an area of 650 acres and represents rich greenery having different tree species.The four sites have been selected to know the TVOC concentrations in urban, suburban and control site (GGV campus). The measurements were made during morning time between 10:00 am to 12:00 noon and fifty random instant reading were taken at each site at a time. During March,April, May and June the average of all four month data have been taken into consideration of the summer TVOC status at different sites.

The TVOC concentration was measured at a site by using the instrument TVOC analyser (Phochech Tiger), Ion Science U.K. Phochech Tigerworks on the principle of the PID detection and measures 450 different types of VOCs and gives a total concentration of TVOC (ppb) for a particular point of the site.

RESULT AND DISCUSSION

The average TVOCs concentrations of month March to June 2017 of urban, suburban and control site were recorded and presented in Fig 1, Fig 2 and Fig 3. The significant temporal variations of TVOCs at each point of the study site were obtained. The results show that the TVOCs concentration in urban and suburban areas was highest wherethe vehicular load was high in contrastto the control site where TVOCs concentration was lowest. This is due togreenery and low vehicular load. VOC emission could not only be resulted from the industrial sources but also be affected by surrounding traffic sources[10].Everydaya large amount of VOCs is released from both stationary and mobile anthropogenic sources. The major sources of VOCs arean industrial process, oil refining and vehicular movement, the use of solvents containing products and agricultural sources[1,11]. TVOCs and Ozone concentration were higher where the heavy vehicular load has been recorded and lowest at a residential area having controlled vehicular movement, surrounded by natural forest cover[12].

Site description

Table1: Description of sites in control, urban and suburban area.

Site name	Type	Site name	Type	Site name	Type
C1	Forestry Nursery site	SU1	Vehicular pollution	U1	Vehicular pollution
C2	HighTree cover	SU2	Bus stand	U2	Less Vehicular pollution
C3	Residential area	SU3	Heavy traffic	U3	Moderate Vehicular load
C4	Vehicle parking site	SU4	Open area	U4	High vehicular load

C-Control site, SU-suburban site, U-urban site

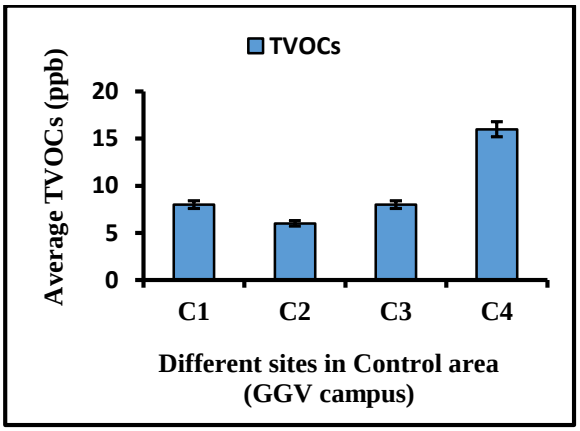

Fig 1: TVOCs concentration at Control site. All values are average(n=50)±SD during March, April, May and June

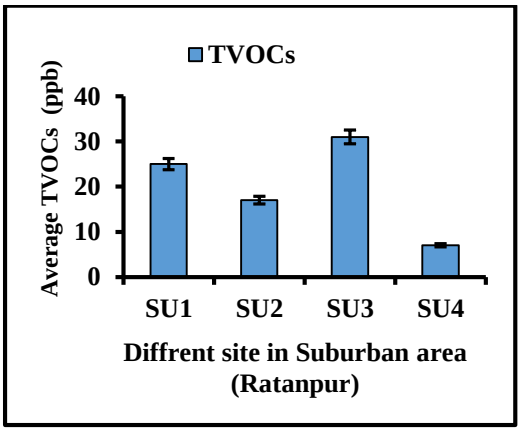

Fig 2: TVOCs concentration at suburban site. All values areaverage (n=50)±SD during March, April, May and June

At the control sites of C1, C2, C3 and C4, the TVOCs concentrations were 8±1.0 ppb, 6±0.8 ppb, 8±1.0 ppb and 16±1.3 ppb respectively. The highest concentration of TVOCs was 16±1.3 ppb at the C4 site were motor vehicle parking was prominent. Motor vehicle parking may lead to high concentrations of TVOCs in ambient air. Earlier it has also been shown that parking area is the source of TVOCs[13]. The site C2 in the campus is surrounded by green trees and there was less vehicular load showing the 6±0.8 ppb TVOCs concentration which is minimum.

The suburban sites at SU1, SU2, SU3 and SU4 showinga higher concentration of TVOCs compared to the control sites. The sites SU1, SU2, SU3 and SU4 are marked in Ratanpur suburban area which is 20 km away from the Bilaspur city. At these locations,the minimum level of TVOC has recorded 7±0.6 ppbat SU4 site and maximum at SU3 site (31±2.7ppb)

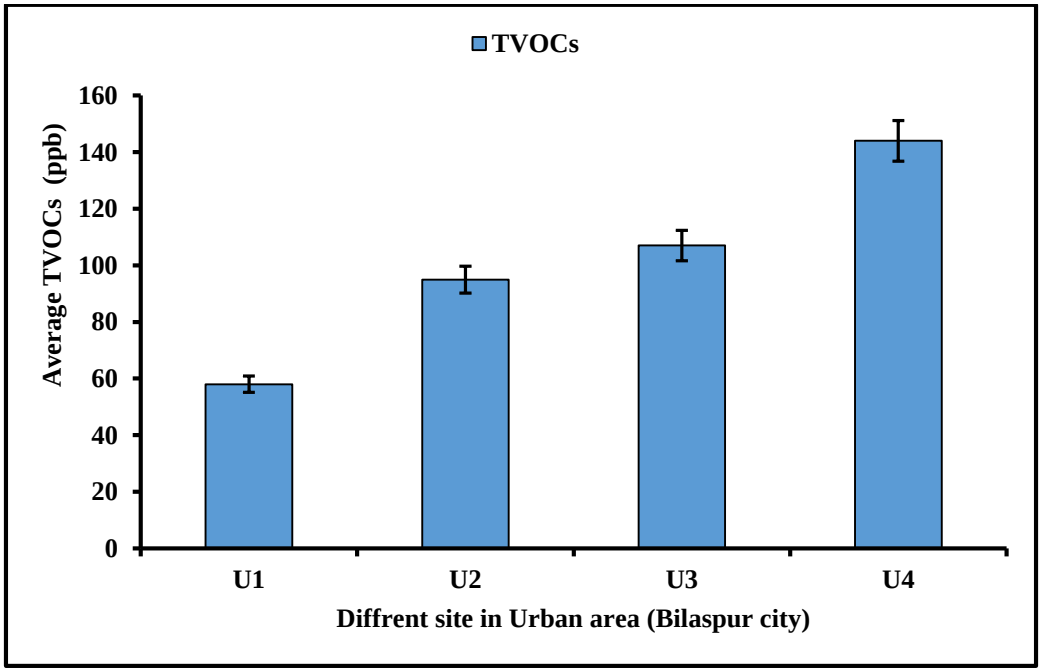

Fig 3:TVOCs concentration at urban site. All values are average (n=50)±SD during March, April, May and June.

In urban area, TVOCs concentrations were higher than the control site and the concentrations were 58±2.85 ppb, 95±3.2 ppb, 107±4.75 ppb and 144±5.18 ppb at U1, U2, U3& U4. The site U4 (Railway station) having thehighest vehicular load of transportation.All vehicular sourcesemitting the hydrocarbon that leads to the highest 144±5.18 ppb TVOCs concentration among urban site. The site U1 showing the 58±2.85 ppb TVOCs concentrations.U1 site has large open diffusing area so the diffusion of gases were faster in the atmosphere and this lead to lower TVOC concentration at ground level at this site.This results are inconsistent with those reported by[14-16].

It was also observed that the ozone production in the lower troposphere occurs by reaction of NOx ($NO+NO_2$) and VOCs (VOCs, consisting mainly of hydrocarbon) in the presence of sunlight[17]. The high concentration of ozone effects trees and crop physiology by reducing the photosynthesis rate. Ozone dose of 20 ppm results in a photosynthesis reduction of 7% for conifers, 36% for hardwood and 73% for crops[18].

CONCLUSION

A study about TVOC concentration in ambient air of urban and suburban area was carried out to understand the concentration distribution of TVOCs with respect to different vehicular load type of location. It was observed that the concentration of TVOCs at a different location in urban, suburban and control site was directly influenced by the concentration of population and motor vehicle movement. TVOCs generated toxic gasses cause both visible and physiological damage to a living organism. The TVOCs in the urban area of Bilaspur city needed to monitored continuously as the level of TVOCs increase as per vehicular load and conversion of available O_3 into TVOC. Green area and tree cover lowers the TVOC concentration due to comperative lower temperature at these sites and conversion of O3 ↔ TVOC become slower at low temperature.

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