GAS CHROMATOGRAPHY –MASS SPECTROMETRY(GC-MS) ANALYSIS OF VOLATILE ORGANIC COMPOOUNDS IN MATHARE AREA-KENYA

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Preliminary Experimental Design for VOC- Kenya

Materials & Method

The traps were prepared by weighing 10g of activated charcoal mesh 100 and packed in whatman filter paper from Machinery and Nagel Whatman 27,045um sachets for the 4 trapping points which were indentified and preserved in Mathare 4B, Mlango Kubwa, Mathare 3B and 3C which are residential areas within the Mathare slums. The traps were cleaned using soxhlet apparatus in Dichloromethane for Tendia DCM GC grade 99.0% and then oven dried @ Temperatures from 40-100C in hot air regulated oven to remove residual volatiles during packing. The traps were stored wrapped in aluminium foil and kept in air tight glass container then kept in refrigerator prior to trapping. The traps were then ferried to the designated point in Mathare at secured locations with help of one of the community assistants. After 24hrs the traps were removed and wrapped separately in aluminium foils well labelled prior of laboratory analysis. Each trap was eluted with 100ul pentane in glass vial 1.5ml GC grade Pentane 99.9% and 5ul of each sample injected into Gas Chromatography Mass spectrometry (GC-MS) as with conditions as below;
Gas Chromatography –Mass spectrometry conditions

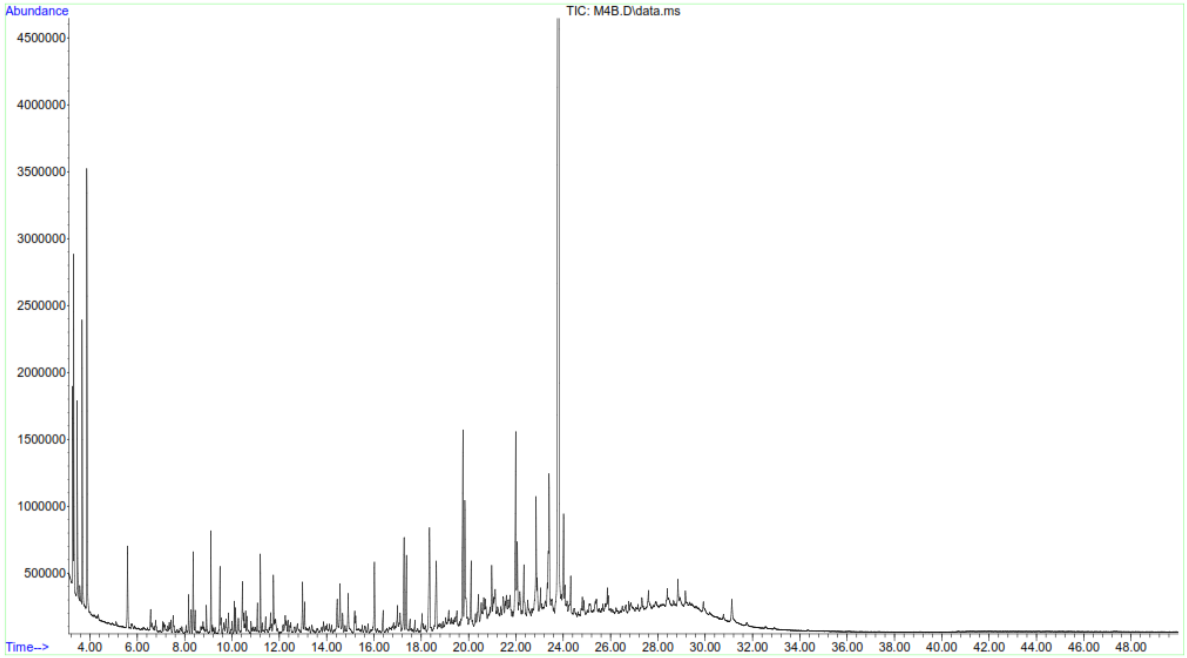
GC/MS Parameter

GC/MS analysis was carried out using an Agilent 7890A Gas Chromatograph coupled to an Agilent 5975C mass spectrometer equipped with an HP5 capillary column, 30 m long, 0.25 μm i.d., and a 0.25 μm film thickness. The temperature of the column was programmed from 50 °C (2 min) to 120 °C, at a rate of 15 °C per minute, and the final ramp reached 250 °C, at an increasing temperature rate of 5 °C per minute. Helium grade 5.0 was used as Carrier gas at a flow rate of 1 mL/minute. Split/splitless (splitless mode) inlet temperature was 280 °C as was that of the mass spectrometry transfer line (Fu and Kawamura, 2010). The temperature of the ion source was maintained at 230 °C. The mass spectrometer was operated Under electron ionization mode at 70 eV. Mass spectra and the total ion chromatograms were Obtained by automatic scanning a mass range (m/z) of 45400. Three runs per sample (n=3) were performed. The components were identified by comparing the mass spectrum with those available in the Nist spectra library.

Chemical composition is reported as the Percentage of relative area, after obtaining the sum of all peak areas in the chromatogram.

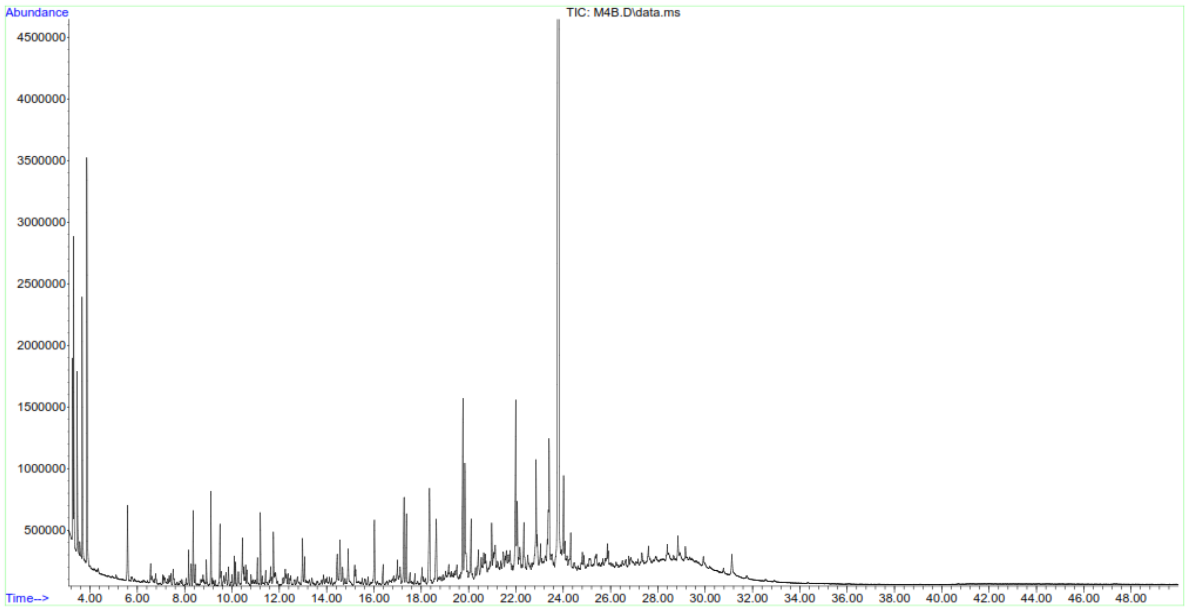
Results and Discussion

Mathare 4B Sample1



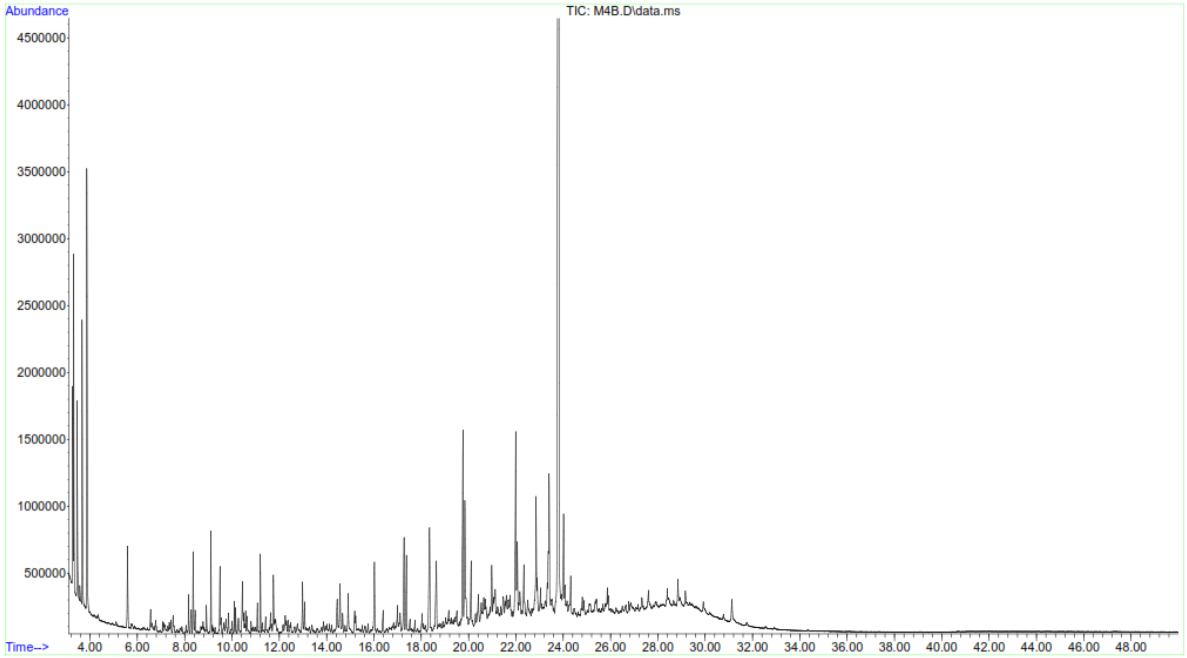
Mathare 4B Sample 1 exhibited major compounds such; 2 –Propanol methyl (2.4%) 2 –Pentanone (4.3%) 2 propanol,1 methylmethoxy(18.3%),Hexanal (10.2%),2,4 Dimethyl-1-heptene (10.2%) P-Xylene (20.6%), Ethylbenzene (3.4%) Trimethyl benzene,1,2,4 (9.5%) Limonene (6.4%) Benzene -1-methyl-3-(1-methyl(7.2%)Pentadecanol<n-> (2.4%) Hexadecene<1-> (2.9%) Di-sec-butyl phthalate (3.0%)7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione (3.1%)9-Octadecenamide, N,N-dimethyl- (3.9%) Pentacose (3.2%) Octadecane, 2,6,10,14-tetramethyl- (4.2%) Nonacosane (5.0%) and Heptacosane (3.0%) .

Mathare 4B sample 2



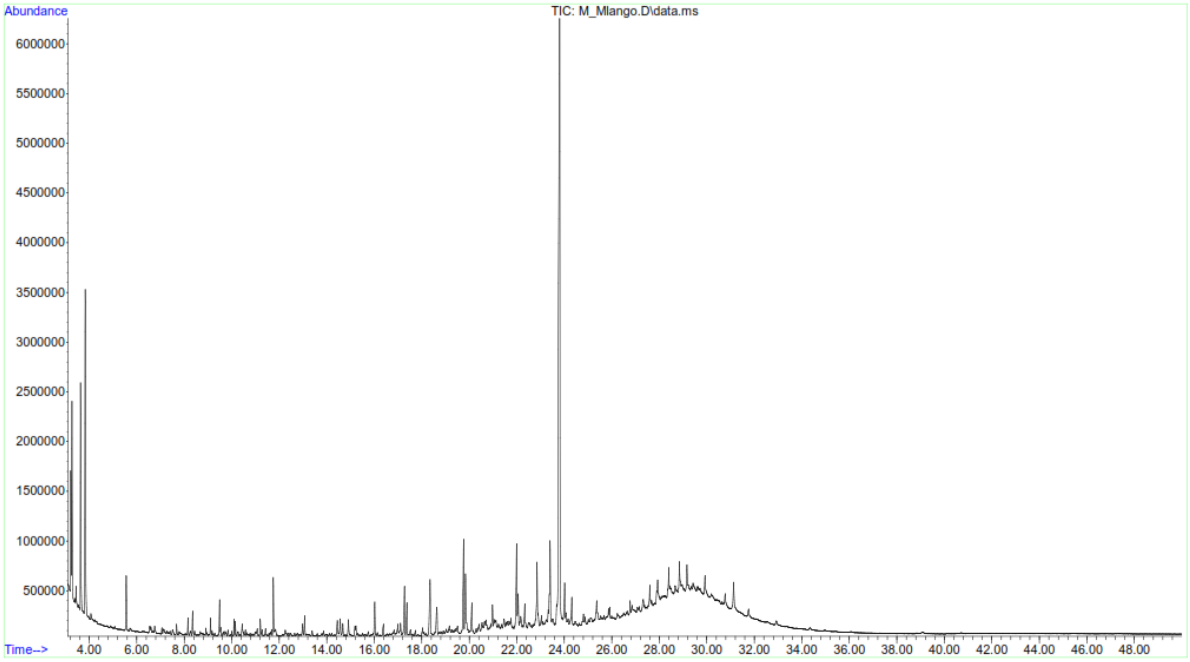
Mathare 4B sample 2 exhibited Major compounds such as; 2 –Propanol methyl (2.4%) 2 –Pentanone (4.3%) 2 propanol,1 methylmethoxy(18.3%),Hexanal (10.2%),2,4 Dimethyl-1-heptene (10.2%) P-Xylene (20.6%), Ethylbenzene (3.4%) Trimethyl benzene,1,2,4 (9.5%) Limonene (6.4%) Benzene -1-methyl-3-(1-methyl (7.2%)Pentadecanol<n-> (2.4%) Hexadecene<1-> (2.9%) Di-sec-butyl phthalate (3.0%)7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione (3.1%)9-Octadecenamide, N,N-dimethyl- (3.9%) Pentacose (3.2%) Octadecane, 2,6,10,14-tetramethyl- (4.2%) Nonacosane (5.0%) and Heptacosane (3.0%) .

Mathare 4B sample 3



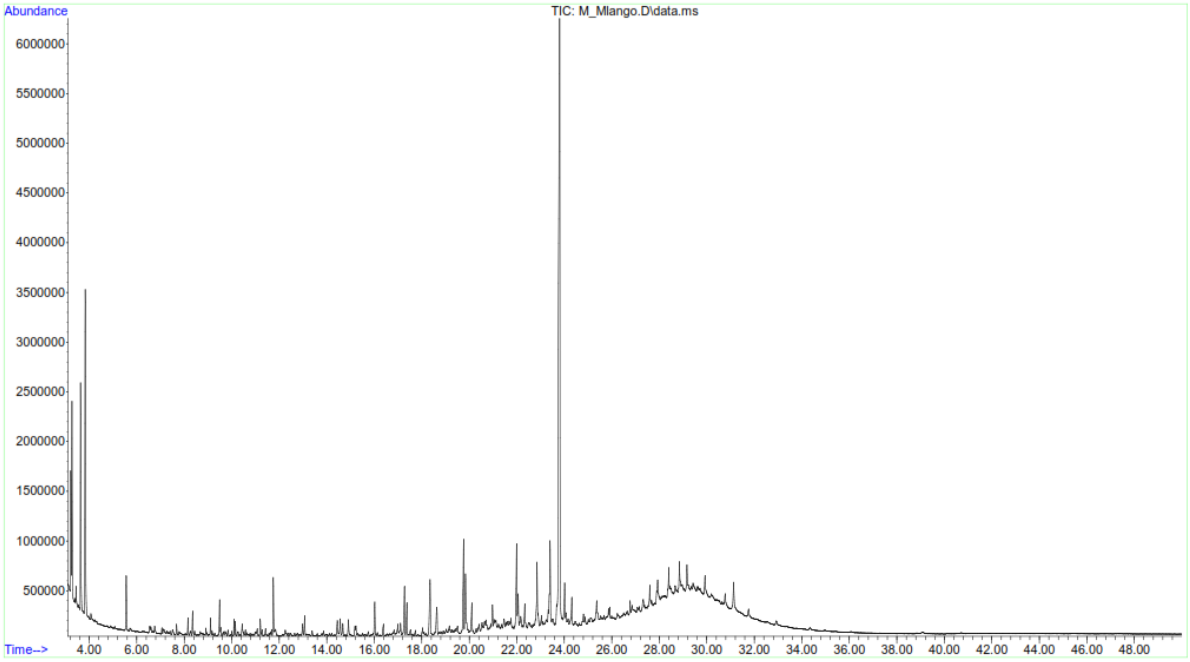
Mathare 4B sample 3 exhibited Major compounds such as;2-Pentanone (4.3%), 2-Propanol, 1-(1-methylethoxy)- (8.3%), Toluene (11.5%), Hexanal (9.2%), p-Xylene (19.6%), Limonene (1.4%), Tridecane (1.0%), Tetradecene<1-> (1.5%), Tetradecane (C14) (1.0%), 2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)- (2.2%), Pentadecanol<n-> (2.9%), Hexadecane (C16) (2.4%), 6-Isocedrol (1.2%), Heptadecane (C17) (1.0%), Hexadecene<1-> (2.9%), Isopropyl tetradecanoate (1.1%), Di-sec-butyl phthalate (3.0%), 7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione (3.1%), i-Propyl 14-methyl-pentadecanoate (1.2%), Oleic Acid (1.5%), Methyl dehydroabietate (1.6%), Tetracosane (1.8%), 9-Octadecenamide, N,N-dimethyl- (3.9%), Pentacosane (3.1%), Octadecane, 2,6,10,14-tetramethyl- (4.2%), Nonacosane (5.0%), Heptacosane (3.1%), 2-methyloctacosane (1.9%), Squalene (1.8%)

Mathare Mlango Kubwa Sample 1



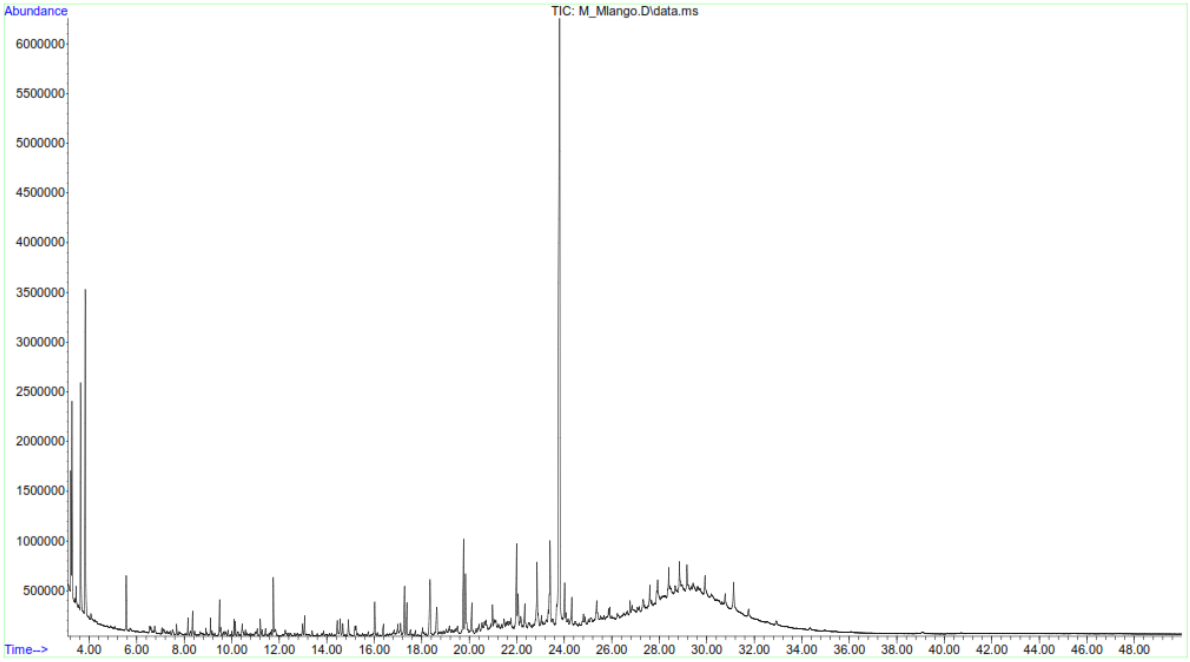
Mathare Mlango Kubwa Sample 1 exhibited Major compounds such as: 2-Pentanone (4.3%), 2-Propanol, 1-(1-methylethoxy)- (8.3%), Tolouen (1.5%), p-Xylene (8.6 %), Tetradecene<1-> (1.5%), 2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)- (2.2%), 6,6-Diethylhoctadecane (1.2 %), Pentadecanol<n-> (2.9%), Hexadecane (C16) (2.4%), Hexadecene<1-> (2.9%), Di-sec-butyl phthalate (3.0 %), 7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione (3.1 %), i-Propyl 14-methyl-pentadecanoate (1.2 %), Oleic Acid (1.5 %), Methyl dehydroabietate (1.6%), Tetracosane (1.8%), 9-Octadecenamide, N,N-dimethyl- (3.9%), Pentacosane (3.2 %) , Octadecane, 2,6,10,14-tetramethyl- (4.2%), Nonacosane (5.0%), Heptacosane (3.1%), 2-methyloctacosane (1.8%).

Mathare Mlango Kubwa Sample 2



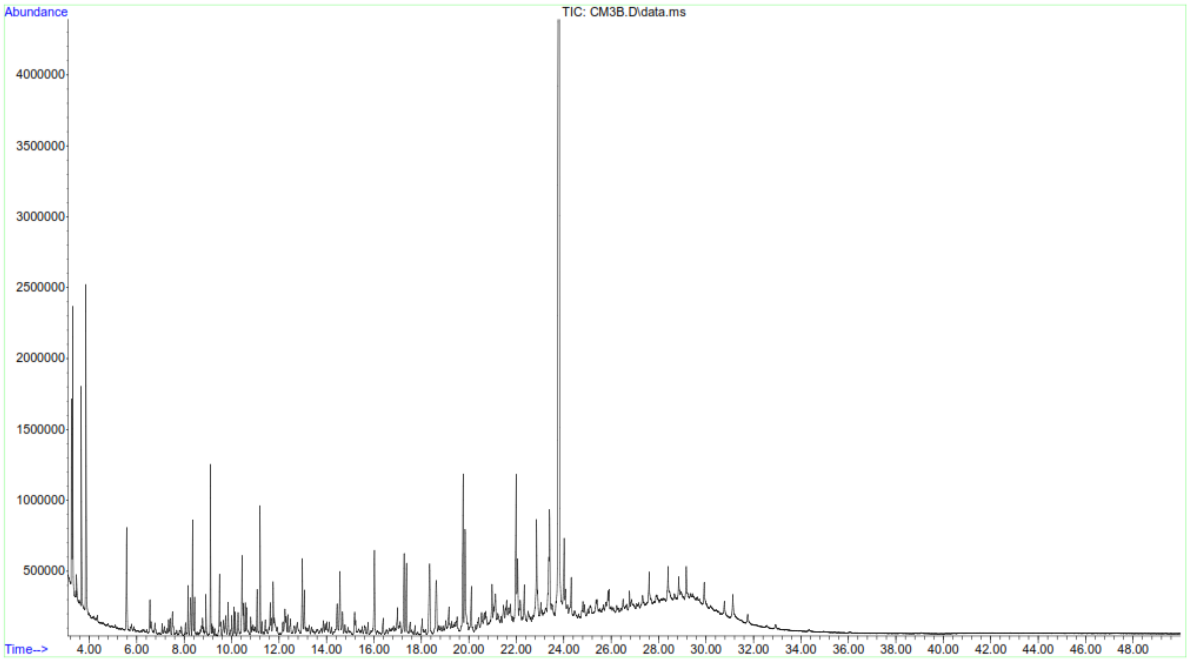
Major compounds such as: 2-Propanol, 1-methoxy- (6.4%), 2-Pentanol (3.1%), 2-Pentanone 4.3%, 2-Propanol, 1-(1-methylethoxy)- (8.3%), Toluene (7.5%), Hexanal (7.2%), Acetic acid, butyl ester ((41.1%), Cyclotrisiloxane, hexamethyl- (1.1%), 2,4-Dimethyl-1-heptene (4.2%), p-Xylene (13.6%), Heptanal (3.1%), Butanoic acid, 4-hydroxy- (9.0%), 3-Hexene, 3-ethyl-2,5-dimethyl- (3.7%), Octane, 2,6-dimethyl- (2.1%), Cyclohexane, 1-methyl-2-propyl- (3.0), Limonene (1.4%), Isophorone (5.2%), Tridecane (5.0), Tetradecene<1-> (1.5%), Tetradecane (C14) (1.0%), 2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)- (3.2%), Pentadecanol<n-> (2.9%), Hexadecane (C16) 2.4%, 6- Isocedrol 1.2%, Heptadecane (C17) (1.0%), Hexadecene<1-> (12.9%), Di-sec-butyl phthalate (3.0%), 7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione (3.1%), i-Propyl 14-methyl-pentadecanoate (1.2%), Oleic Acid (1.4%), Methyl dehydroabietate (1.6%), Tetracosane (1.8%), 9-Octadecenamide, N,N-dimethyl- (3.9%), Pentacosane (3.2%), Octadecane, 2,6,10,14-tetramethyl- (4.2%), Nonacosane (5.0%), Heptacosane (7.1%), 2-methyloctacosane (1.9%), Squalene (1.8%)

Mathare Mlango Kubwa Sample 3



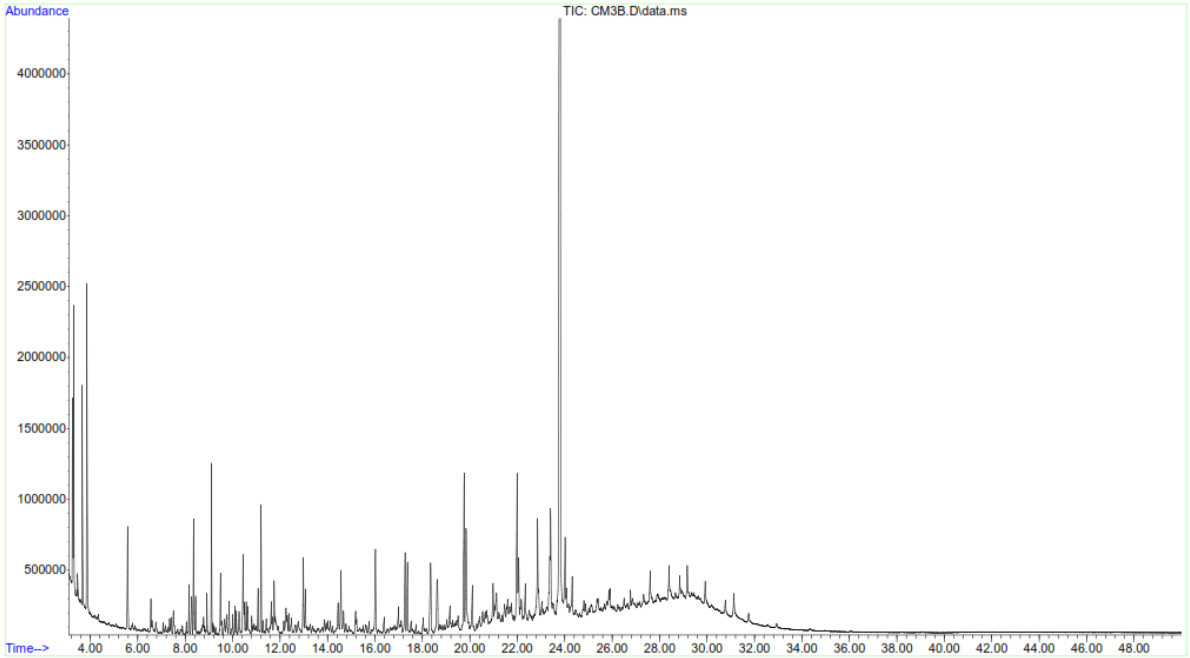
Mathare Mlango Kubwa Sample 3 exhibited Major compounds such as: 2-Propanol, 1-methoxy- (5.4%), 2-Pentanol (3.1%), 2-Pentanone (4.3%), 2-Propanol, 1-(1-methylethoxy)- (8.3%), Toluene (11.5%), p-Xylene (10.6%), Trimethyl benzene<1,2,4-> (9.5%),Cyclohexane, 1-methyl-2-propyl- (1.0%), Limonene (1.4%), Decane, 4-ethyl- (10.3%), Decane, 3-methyl- (2.1%), Benzene, 1-methyl-3-(1-methylethyl)- (10.2%), Tridecane (1.0%), Tetradecene<1-> (1.5%), 2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)- (2.2%), 6,6-Diethylhoctadecane (1.2%), Pentadecanol<n-> (2.9%), Hexadecane (C16) (2.4%), 6- Isocedrol (1.2%), Heptadecane (C17) (1.0%), Hexadecene<1-> (12.9%), Di-sec-butyl phthalate (3.0%), 7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione (3.1%), 1-Hexacosanol (10.3%), Oleic Acid (11.5%), Methyl dehydroabietate (1.6%), Tetracosane (1.8%),9-Octadecenamide, N,N-dimethyl- (3.9%), Pentacosane (3.2%), Octadecane, 2,6,10,14-tetramethyl- (4.2%), Nonacosane (5.0%), Heptacosane (3.1%), 2-methyloctacosane (1.9%), Squalene (1.8%)

Mathare 3B Sample 1



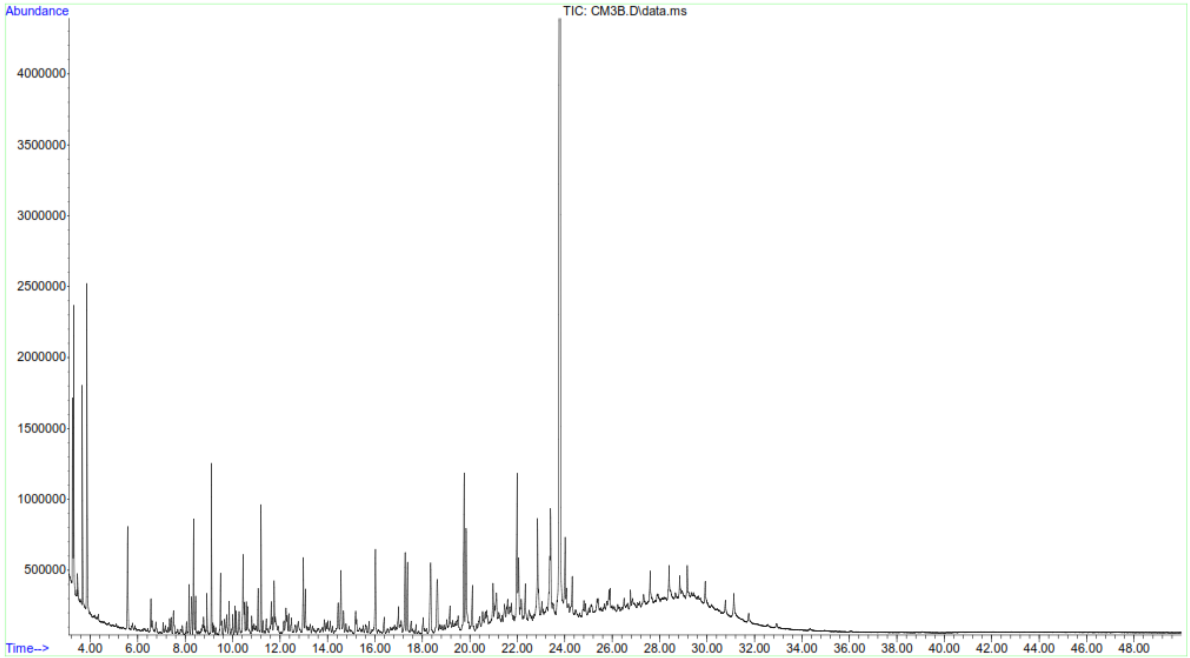
Mathare 3B sample 1 exhibited Major compounds such as: 2-Pentanone (12.8%), 2-Propanol, 1-(1-methylethoxy)- (15.3%), Toluene (2.8%), Hexanal (10.3), p-Xylene (11.9%), Nonane<n-> (6.2%), 2-Butenal, 3-methyl- (1.0%), Benzene, 1-ethyl-2-methyl- (4.6%), Decane<n-> (1.9%), Limonene (1.0%), Undecane<p-> (3.5%), 1-Ethyl-2-pyrrolidinone (1.1%), Cyclododecane (1.0%), Dodecane (9.4%), Tridecane (1.8%), Tetradecane (C14) (5.5%), 2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)- (2.0%), Tetradecene<1-> (3.3), Hexadecane (C16) (18.7%), 6- Isocedrol (1.2%), Heptadecane (C17) (1.2%), Hexadecene<1-> (3.8%), Octadecane (C18) (1.5%), Hexadecane, 2,6,10,14-tetramethyl- (1.3%), Isopropyl tetradecanoate (1.6%), Hexadecane, 7,9-dimethyl- (1.2%), Benzene, (1-methyldodecyl)- (1.5%), 1-Heptadecene (2.4%), Isopropyl hexadecanoate (2.1), 9-methylheptadecane (1.1%), Eicosene<1-> (1.2%), Cyclohexane, tetradecyl- (1.1%), Methyl dehydroabietate (1.6%), Pentacosane (2.4%), Hexacosane (12.9%)

Mathare 3B Sample 2



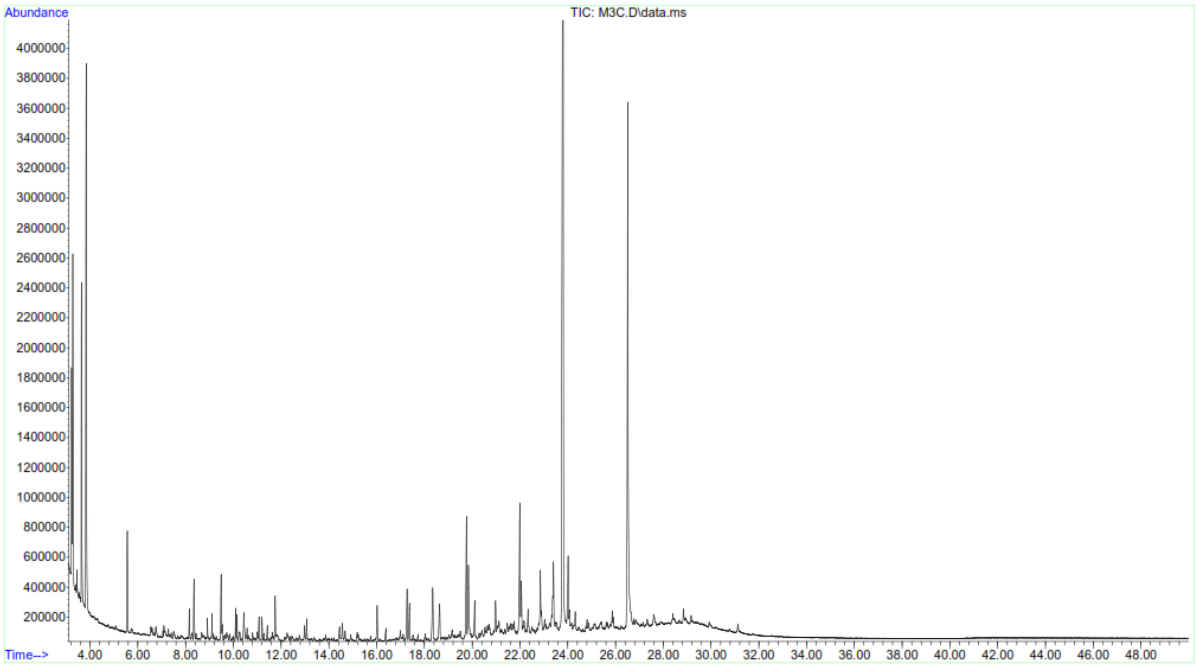
Mathare 3B sample 1 exhibited major compounds such as:2-Pentanone (4.8%), 2-Propanol, 1-(1-methylethoxy)- (7.3%), Toluene (5.8%), p-Xylene (6.9%), Nonane<n-> (8.2%), 2-Butenal, 3-methyl- (7.0%), Benzene, 1-ethyl-2-methyl- (1.6%) , Decane<n-> (6.9%), Limonene (1.0%), Undecane<p-> (4.5%), Dodecane (3.4%), Tridecane (1.8%), Tetradecane (C14) (1.5%), 2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)- (3.0%), Tetradecene<1-> (3.3%), Hexadecane (C16) (2.7%), -Isocedrol (1.2%), Heptadecane (C17) (1.2%), Heptadecane, 3-methyl- (1.0%), Hexadecene<1-> (3.8%), Octadecane (C18) (1.5%), Hexadecane, 2,6,10,14-tetramethyl- (1.3%), Isopropyl tetradecanoate (1.6%), Hexadecane, 7,9-dimethyl- (1.2%), Benzene, (1-methyldodecyl)- (1.5%), 1-Heptadecene (7.4%), Isopropyl hexadecanoate (9.1%), 9-methylheptadecane (1.1%), Eicosene<1-> (1.2%), Cyclohexane, tetradecyl- (1.1%), Methyl dehydroabietate (1.6%), Pentacosane (2.4%), Hexacosane (4.9%)

Mathare 3B Sample 3



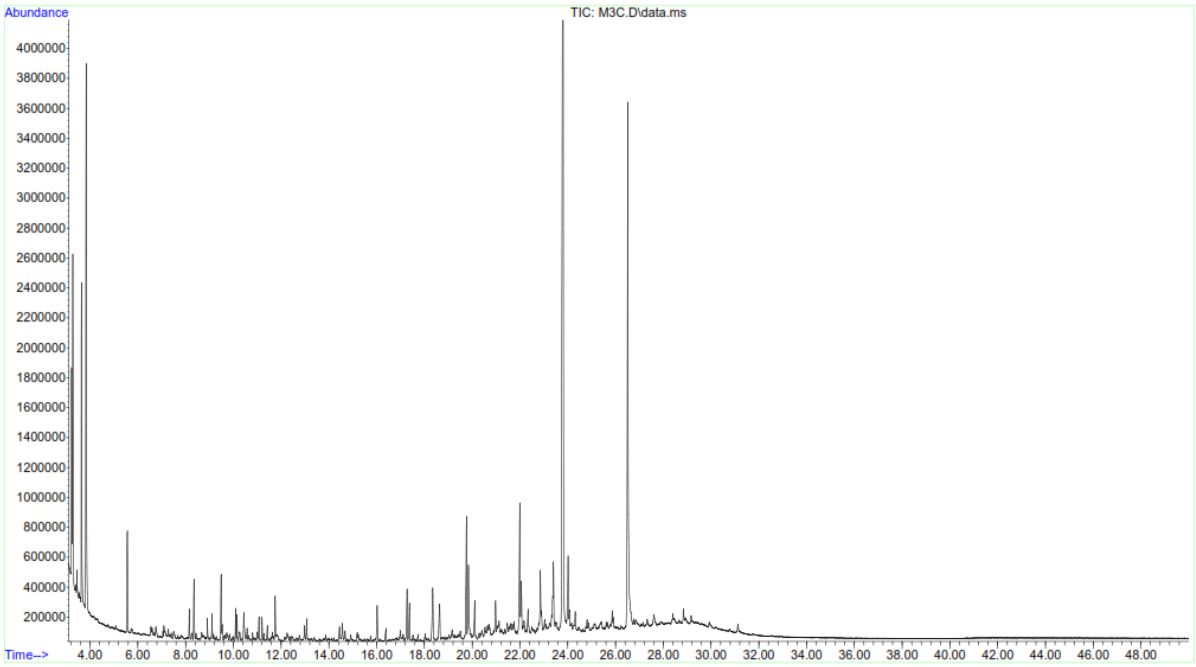
Mathare 3B sample 2 exhibited Major compounds such as:2-Pentanone(2.8%), 2-Propanol, 1-(1-methylethoxy)- (5.3%), Toluene (1.8%), p-Xylene (10.9%), Nonane<n-> (12.2%), 2-Butenal, 3-methyl- (1.0%), Benzene, 1-ethyl-2-methyl- (8.6%), Decane<n-> (9.9%), Limonene (8.0%), Cymene<o> (10.4%), Undecane<p-> (1.5%), Dodecane (1.4%), Tridecane (1.8%), Tetradecane (C14) (1.5%), 2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)- (2.0%), Tetradecene<1-> (3.3%), Hexadecane (C16) (2.7%), 6- Isocedrol (1.2%), Heptadecane (C17) (1.2%), Heptadecane, 3-methyl- (1.0%), Hexadecene<1-> (3.8%), Octadecane (C18) (1.5%), Hexadecane, 2,6,10,14-tetramethyl- (1.3%), Isopropyl tetradecanoate (1.6%), Hexadecane, 7,9-dimethyl- (1.2%), Benzene, (1-methyldodecyl)- (1.5%), 2-methyloctacosane (1.1%), 1-Heptadecene (9.4%), Isopropyl hexadecanoate (7.1%), 9-methylheptadecane (1.1%), Eicosene<1-> (1.2%), Cyclohexane, tetradecyl- (1.1%), Methyl dehydroabietate (1.6%), Pentacosane (2.4%), Hexacosane (2.9%),

Mathare 3C 1



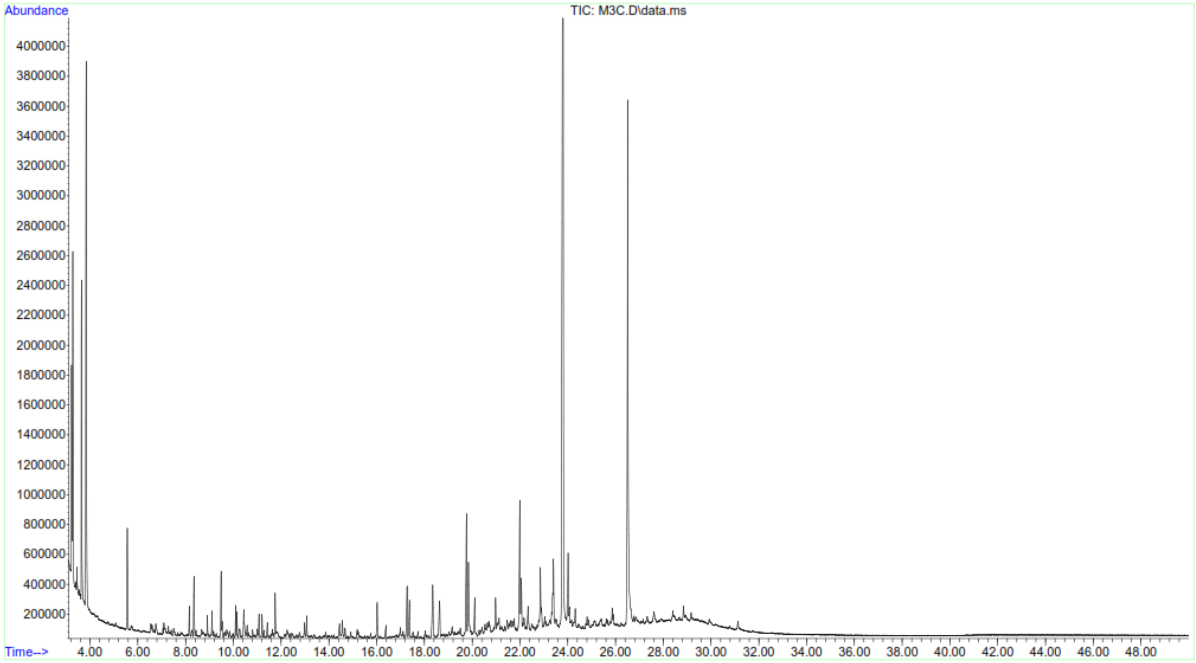
Mathare 3C sample 1 exhibited Major compounds such as:2-Butanone, 3-methyl- (5.1%), 2-Pentanone (7.1%), 2-Pentanol (15.9%), Toluene (3.1%), p-Xylene (11.7%), Limonene (1.2%), Tridecane (1.2%), Tetradecene<1-> (1.8%), Tetradecane (C14) (1.3%), 2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)- (2.4%), 6,6-Diethylhoctadecane (1.6%), Hexadecene<1-> (9.2%), Hexadecane (C16) (3.1%), Cedrol (3.7%), Heptadecane (C17) (1.4%), Octadecene<1-> (8.9%), Octadecane (C18) (1.8%), Isopropyl tetradecanoate (1.3%), Isopropyl hexadecanoate (1.3%).

Mathare 3C Sample 2



Mathare 3C sample 2 exhibited Major compounds such as:2-Butanone, 3-methyl- (5.1%), 2-Pentanone (7.1%), 2-Pentanol (15.9%), Toluene (3.1%), p-Xylene (9.7%), 1-Methoxy-4,4-dimethyl-cyclohex-1-ene (8.4%), Benzene, (1-methylethyl)- (2.3%), Citronellene<tetrahydro-> (2.2%), Cyclohexane, (1,2,2-trimethylbutyl)- (10.4%), Mesitylene (10.4%), Trimethyl benzene<1,2,4-> (7.6%), Decane<n-> (6.6%), Limonene (1.2%), Nonanal(2.7%),Tridecane (1.2%), Tetradecene<1-> (1.8%), Tetradecane (C14) (1.3%), 2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)- (12.4%), 6,6-Diethylhoctadecane (1.6%), Hexadecene<1-> (14.2%), Hexadecane (C16) (13.1%), Cedrol (1.7%), Octadecene<1-> (14.9%), Octadecane (C18) (1.8%), Isopropyl tetradecanoate (1.3%), Isopropyl hexadecanoate (1.3%), Cyclohexane, nonadecyl- (8.4%), 1-Propene-1,2,3-tricarboxylic acid, tributyl ester (4.3%), Docosane (7.4%), Dodecane, 2,6,10-trimethyl- (8.6%), Hexacosane (3.4%), Supraene (5.5%)

Mathare 3C Sample 3



Mathare 3C sample 3 exhibited Major compounds such as:2-Butanone, 3-methyl- (5.1%), 2-Pentanone (7.1%), 2-Pentanol (15.9%), Toluene (9.1%), p-Xylene (8.7%), 2-Butenal, 3-methyl- (1.7%), 1-Methoxy-4,4-dimethyl-cyclohex-1-ene (2.4%), Trimethyl benzene<1,2,4-> (1.6%), Limonene (1.2%), 1,4-Cyclohexadiene, 3-ethenyl-1,2-dimethyl- (5.2%), Nonanal (9.7%), Cyclohexane, hexyl- (11.3%), Tridecane (1.2%), Tetradecene<1-> (3.8%), Tetradecane (C14) (1.3%), Cedrene<alpha-> (2.5%), Cyclohexane, octyl- (9.3%), 2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)- (12.4%), 6,6-Diethylhoctadecane (1.6%), Hexadecene<1-> (14.2%), Hexadecane (C16) (13.1%), Cedrol (1.7%), Heptadecane (C17) (1.4%), Octadecene<1-> (4.9%), Octadecane (C18) (1.8%), Isopropyl tetradecanoate (1.3%), Isopropyl hexadecanoate (1.3%),

Summary for Results and Discussion

The Ms spectra integration of the peaks for Sample from Mathare 3B ,4B, MlangoKubwa and Mathare 3C trapped and analyzed by GC-MS has similar Ms spectra with most of the compounds eluting at similar retention times but variations in % Compositions;

Conclusion

The volatiles' organic carbons indentified from the samples above are basically classified such as ; aliphatic ketons, Carboxylic acids, Esters, Aromatic hydrocarbons, terephalic acids, Gasolines, Polycyclic Aromatic Hydrocarbons, These compounds are commonly associated with economic activities and lifestyle of the people in the areas. The Volatile organic compounds are of great concern as they pose risk to the environment and human health. The gas chromatographic methods used to monitor the concentration of volatile organic compounds in Mathare area in all the sites**, the percentage concentration of toluene , paraxylene , octane and 2_Pentanone were the most abundant air contaminant monitored , this being the major contributor to air contamination from engine exhaust gases of internal combustion of vehicles due to intense road traffic and pollution from polythene which are manufactured from paraxylene as their building block** and environmental pollution from nicotiana tabaccum which is a tobacco plant which exists from 2 pentanone and other precursors.

Recommendations

- Comparative study of VOC in different areas in the City
- Customized experimental design for volatile trapping to mitigate external interferences
- Use of various absorbents in the experimental designs
- Designing trapping on for many hours 12,hrs,24hrs,48hrs and 96hrs as apart of environmental monitoring evaluation
- Designing specific and customized trapping areas, ie, Garage, Bars, Kitchen, Petrol stations etc