

Original article

Impact of Garbage Burners on Organic Compound Levels in Atmospheric Air Samples from El Bayda, Libya

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Abstract

This study was conducted to identify and estimate organic compounds in composite air samples from several areas in the city of El Bayda (Libya). Samples were collected from (10) different sites within and around the city during the summer of 2024. Gas Chromatography-Mass Spectrometry (GC-MS) technique was used to measure and identify the types of organic compounds suspended in the air and the effect of garbage fires on them. The results of this study showed the presence of some aliphatic and aromatic hydrocarbons and can be summarized as following: Ethylene oxide, Methylene chloride, 2, 4-dimethyl pentane, 2, 2-dimethylpentane, 2 methyl-Hexane, 3-methylhexane, 1, 2-bis(trimethylsilyl)benzene, methyl Cyclopentane, Methylene chloride, 2-isopropoxyethylamine, Propane, 1-benzazirene-1-carboxylic acid, and other different organic compounds. The total organic Hydrocarbon compounds in the ten studied locations inside and around El-Bayda city were as follows: 75.29, 45.90, 82, 25, 59.65, 13.54, 53.47, 81.65, 216.75, 45.72, and 39.35 µg/g. The study also showed variations in the detected compounds along the studied locations. The results indicated that the total hydrocarbon contents at some locations included some compounds, but were not recorded at these locations. The findings of this study concluded that the presence of organic compounds in the samples from the study area may be due to garbage fires near the city.

Keywords: Hydrocarbons, GC-Mass, Garbage Fires, Atmosphere City, Libya.

Introduction

Air pollution is among the major environmental health risk factors, estimated to cause between four and nine million deaths globally. Among the organic chemicals present in the air, some Polycyclic Aromatic Hydrocarbons (PAHs) are believed to possess the highest toxic potential in terms of cytotoxicity, mutagenicity, and carcinogenicity [1]. High molecular weight PAHs containing five or more aromatic rings are found primarily associated with particulate matter, while smaller PAHs containing four or fewer aromatic rings are found to a greater extent in the gas phase [2]. However, due to their higher total concentrations in air compared to larger PAHs, low molecular weight PAHs nevertheless tend to be the dominant particle-associated PAHs [3]. Levels of particulate-associated phenanthrene and pyrene from diesel exhaust and wood smoke typically exceed the carcinogenic benzo(a)pyrene benchmark level by orders of magnitude. The relative quantity of particle-associated PAHs depends on the source, but is also significantly influenced by temperature [4]. Consequently, particle-associated PAH levels during winter may be up to ten times higher compared to summer, when the more volatile PAHs evaporate to a greater extent and exist in the gas phase.

Although indoor sources also contribute to total airborne PAH exposure, indoor air is often influenced by outdoor sources [5]. The objective of this study is to determine the types and concentrations of hydrocarbon substances emitted from waste burning in some areas within Al Bayda city, and to compare the obtained results with air samples from some other cities. In Libya some studies were carried to estimate the hydrocarbon levels in different samples by used GC-Mass [6-14], the environmental studies were established for determine heavy metals [15-44], plants [45-76], beside many of studies attempted the treatment of different wastes [77-85], radioactive elements [86-88], pesticides [89], Most of these studies recorded high pollutants levels the studies samples causing by human activities

Methods

Description of the Study Area

Samples were collected from various locations in Al Bayda, including sites near the landfill and other scattered areas within the city. A total of 10 sites were selected at different distances from El-Bayda city (Figure 1), showing the position of El-Bayda city on the Libyan map.

Sample Collection

The study area was divided into 10 sites, including several locations in and around El Bayda city, as shown in Figures 2-4 and Table 1.



Figure 1. Position of El-Bayda city on the Libya map

Table 1. The sample locations

Location	Simple No.
1	Near landfill
2	Near landfill
3	Near landfill
4	Near landfill
5	Rafi' al-Ansari
6	Bo-habib
7	Wardamah
8	Bo-Sultan
9	Al-Dhaman
10	Sport City



Figure 2. The locations of study (El-Bayda City)



Figure 3. The accumulation of garbage in some residential neighborhoods of El Bayda city, Libya.



Figure 4. The garbage fire of some study locations.

Sample Preparation Methods

Modified air sample collections were used in this study. A plastic pipe (1 M) length) with aluminum gauze fixed on the inside of it, then a small piece of white cloth (25 cm x cm was placed on the gauze. The equipment was left for some days at the studied locations (10 sites were selected in this study around the city). After that, each sample was placed in distilled water for 24 hours, followed by filtration of each sample and placing it in a sealed sterile container with the sample number recorded. The samples were then taken to the laboratory to identify the hydrocarbon substances therein.

Hydrocarbon Compound Measurement Methods

Sample concentrations were measured using Gas Chromatography (GC-MS) techniques, Perkin Elymnar model (At Alexandria University, Egypt), according to methods described by previous studies [7-12].

Results

Tables 2-11 indicate the types and concentrations of hydrocarbon compounds in the study area samples. The following compounds were recorded

Table 2. Concentrations ($\mu\text{g/g}$) of Hydrocarbon Compounds at Site No. (1)

Compound's name	Concentration ($\mu\text{g/g}$)
Ethylene oxide	0.40
Methylnitroso -Carbamic acid	0.29
2-propoxy-Ethanamine	0.25
Methylene chloride	7.28
Hexane	34.10
2,2-dimethyl-Pentane,	2.28
Methyl Cyclopentane	12.86
2-methyl -Hexane	0.26
, 3-methyl Hexane	0.18
1-Hexanamine, N-nitro	0.15
Benzenemethanamine,N(phenylmet	0.19
Silane, 1,4-phenylenebis [trimethyl-	13.09
4Methyl-2-trimethylsilyloxy-ace	1.88
1,1,1,3,5,5,5-Heptamethyltrisilo	0.68
1,2-Bis(trimethylsilyl)benzene	0.92
Trimethyl [4-(2-methyl-4-oxo-2-pe	0.48
Total	75.29

Table 3. Concentrations ($\mu\text{g/g}$) of Hydrocarbon Compounds at Site No. (2)

Compound's name	ppm Concentration
Ethylene oxide	0.52
Methylene chloride	1.48
2,4-dimethyl-Pentane	3.76
2,2-dimethyl-Pentane	2.76
Cyclopentane, methyl-	7.71
2-methyl-Hexane	0.3
3-methyl-Hexane	0.19
Azetidine	0.14
Benzenebutanamine	0.12

N.Ethylformamide	0.20
hexamethyl-Cyclotrisiloxane	0.31
2-(trimethylsilo Propiophenone	11.70
1,4-phenylenebis[trimethyl-Silane]	16.31
Total	45.5

Table 4. Concentrations (µg/g) of Hydrocarbon Compounds at Site No. (3)

Compound's name	Concentration (µg/g)
2-Isopropoxyethylamine	13.83
Ethylene oxide	13.32
1-Tetradecanamine	21.19
Cis- Aconitic anhydride	12.47
Nonadecylamine	10.16
2-(3-Methylguanidino) ethanol	2.72
decamethyl, Tetrasiloxane	8.56
Total	82.25

Table 5. Concentrations (µg/g) of Hydrocarbon Compounds at Site No. (4)

Compound's name	Concentration (µg/g)
, 5,5-dichloro-4-Spirohexanone	0.36
Oleylamine	0.25
0-2-pentylhdorxylamine	0.2
, dihydro-3-methyl 2,5-Furandione	0.15
Cis-Aconitic anhydride	0.27
4-Bromo-N-[(2-pyridyl)aminomethy	0.60
Taurolidine	0.84
1,1,3,3,5,5,7,7,9 Octasiloxane	18.98
1-Benzazirene-1-carboxylic acid	2.73
2-(trimethylsilo Propiophenone,	35.27
Total	59.65

Table 6. Concentrations (µg/g) of Hydrocarbon Compounds at Site No. (5)

Compound's name	Concentration (µg/g)
Ethylene oxide	2.80
S-[2-(acety),2-Butenethioic acid	1.49
3-Butyn-1-ol	0.32
Methylene Chloride	6.19
Acetic acid, trifluoro-ethyl e.	0.17
Ethyl chloride	1.72
2-Isopropoxyethylamine	0.64
0-2-Pentylhydroxylamine	0.21
Total	13.54

Table 7. Concentrations (µg/g) of Hydrocarbon Compounds at Site No. (6)

Compound's name	Concentration (µg/g)
Taurolidine	12.54
2-Fluoro-.beta.-alanine	10.23
Ethylamine	10.81
Propane	0.32
dihydro-3-methyl ,2,5-Furandione	19.57
Total	53.47

Table 8. Concentrations (µg/g) of Hydrocarbon Compounds at Site No. (7)

Compound's name	Concentration (µg/g)
2-methyl-Hexane	14.67
tetrahydro-2,5-dimethyl-Furan	13.96
2,2-dimethyl-oxime, Propanal	17.63
tetrahydro-,2-Furanmethanamine	8.62
, 3-propoxy-1-Propanamine	1.93

Propanal	1.41
1-(3-ethyloxiranyl)-Ethanone	1.12
, 3-methyl-Pyrrolidine	0.58
1-aminomethyl-Cyclododecanol	2.65
4,6-dimethoxy-5-nitro-Pyrimidine	12.36
1,2-Benzenedicarboxylic	6.72
Total	81.65

Table 9. Concentrations (µg/g) of Hydrocarbon Compounds at Site No. (8)

Compound's name	Concentration (µg/g)
, dihydro-3-methyl 2,5-Furandione	216.73
Total	216.73

Table 10. Concentrations of Hydrocarbon Compounds at Site No. (9)

Compound's name	Concentration (µg/g)
2-methoxy-Ethanamine	0.99
heptyl, Hydroperoxide	5.52
Glycine, ethyl ester	3.79
, 2-methyl-1-Butanamine	1.34
6-amino-1-Hexanol	2.92
2-Ethoxyethylamine	1.66
Diethyl azodicarboxylate	6.98
Propyne	2.10
Silane	2.40
6-amino-Hexanenitrile	1.63
2-Chloroethylamine	0.87
nitro-Ethane	2.00
2-Chloroethanol	1.68
1,2-Ethanediol	1.81
3-Aminopropionitrile	1.90
Isobutylamine	1.61
2,6-dimethoxy-5-nitro-Pyrimidine	0.72
dihydro-3-methyl...2,5-Furandione	2.13
2-methyl-Adenosine	3.67
Total	45.72

Table 11. Concentrations (µg/g) of Hydrocarbon Compounds at Site No. (10)

Compound's name	ppm Concentration
4,6-dimethoxy-5-nitro-Pyrimidine	0.10
1,2-Ethanediol	0.12
2,4,6(1H,3H,5H)-Pyrimidinetrione	1.78
2H-1,4-Benzodiazepin-2-one,7-ch	0.83
-Cyclooctasiloxane hexadecamethyl	0.93
dodecamethyl-Pentasiloxane	0.82
1,1,3,3,5,5,7,7,9...Heptasiloxane	2.63
,1,1,3,3,5,5,7,7,9,...Octasiloxane	29.02
2-carboxylic acid, 6-1H-Indole	1.09
1-Benzazirene-1-carboxylic acid,	2.26
Total	39.58

Discussion

In this study, which was carried out on some air samples collected from locations inside and around El-Beida city, the hydrocarbon compounds that may be detected using a GC-Mass instrument. The results recorded different hydrocarbon compounds in the studied locations. The highest concentrations were

recorded at Site (7) with a value of (216.73 µg/g), and the lowest concentrations (13.54 µg/g). Generally, total hydrocarbon compound concentrations ranged between (216.73-13.54 µg/g). The concentrations of compounds recorded in this study were as follows: Ethylene Oxide: Highest concentration at Site 3 (13.32), while at Site 5 it was (2.80), and equally at Site 4 (2.80). Lowest concentration at Site 2 (0.52). Not detected at other sites, the types of hydrocarbons detected in this study can be shown as follows: Hexane: Highest concentration at Site (1) at (34.10 µg/g). Not detected at other sites. Methylene Chloride: Highest concentration at Site (1) at (7.28), while at Site (5) it was (6.19) and at Site (2) (1.48). Not detected at remaining the sites.

Carbamic Acid Methylnitroso: Highest concentration at Site (1) at (0.29). Not detected at other sites. Ethanamine,2-propoxy: Highest concentration at Site (1) at (0.25). Not detected at other sites. Pentane, 2, 2-dimethyl-: Highest concentration at Site (2) at (2.76), and at Site (1) it was (2.28). Not detected at other sites. Cyclopentane, methyl: Highest concentration at Site (1) at (12.86 µg/g), while at Site (2) it was (7.71). Not detected at other sites. Hexane,2-methyl-: Highest concentration at Site (7) at (14.67), at Site (2) (0.3), and at Site 1 (0.26). Not detected at other sites. Hexane, 3-methyl-: Highest concentration at Site (2) at (0.19), while at Site (1) it was (0.18). Not detected at other sites. 1-Hexanamine, N-nitro-: Highest concentration at Site (1) at (0.15). Not detected at other sites. Benzenemethanamine, N(phenylwet): Highest concentration at Site (1) at (0.19). Not detected at other sites. Silane,1,4-phenylenebis[trimethyl-]: Highest concentration at Site (2) at (16.31), while at Site (1) it was (13.09). Not detected at other sites. 4-Methyl-2-trimethylsilyloxy-ace: Highest concentration at Site (1) at (1.88). Not detected at other sites. Pentane,2,4-dimethyl-: Highest concentration at Site (2) at (3.76). Not detected at other sites. Azetidine: Highest concentration at Site (2) at (0.14). Not detected at other sites. Benzenebutanamine: Highest concentration at Site (2) at (0.12). Not detected at other sites. N-Ethylformamide: Highest concentration at Site (2) at (0.2). Not detected at other sites. Cyclotrisiloxane, hexamethyl-: Highest concentration at Site (2) at (0.31). Not detected at other sites. Propiophenone,2-(trimethylsilo: Highest concentration at Site (2) at (11.70). Not detected at other sites.

N-Ethylformamide: Highest concentration at Site (2) at (0.20). Not detected at other sites. 2-Isopropoxyethylamine: Highest concentration at Site (3) at (13.83). Not detected at other sites. 1-Tetradecanamine: Highest concentration at Site (3) at (21.19). Not detected at other sites. Cis-Aconitic anhydride: Highest concentration at Site (3) at (12.47), and at Site (4) (0.27). Not detected at other sites. Nonadecylamine: Highest concentration at Site (3) at (10.16). Not detected at other sites. 2-(3-Methylguanidino) ethanol: Highest concentration at Site (3) at (2.72). Not detected at other sites. Tetrasiloxane,decamethyl: Highest concentration at Site (3) at (8.56). Not detected at other sites. 2,5-Furandione, dihydro-3-methyl: Highest concentration at Site (8) at (216.73), while at Site (6) it was (19.57), at Site (9) (2.13), and at Site (4) (0.15). Not detected at other sites. O-2-Pentylhydroxylamine: Highest concentration at Site (5) at (0.21), while at Site (4) it was (0.2). Not detected at other sites. Oleylamine: Highest concentration at Site (4) at (0.25). Not detected at other sites.

4-Spirohexanone,5,5-dichloro: Highest concentration at Site (4) at (0.63). Not detected at other sites. 4-Bromo-N-[(2-pyridyl) aminomethyl: Highest concentration at Site (4) at (0.6). Not detected at other sites. Taurolidine: Highest concentration at Site (6) at (12.54), while at Site (4) it was (0.84). Not detected at other sites. Octasiloxane1,1,3,3,5,5,7,7,9: Highest concentration at Site (10) at (29.02), while at Site (4) it was (18.98). Not detected at other sites. 1-Benzazirene-1-carboxylic acid: Highest concentration at Site (4) at (2.73), while at Site (10) it was (2.26). Not detected at other sites. Propiophenone,2-(trimethylsilo: Highest concentration at Site (4) at (35.27). Not detected at other sites. 2-Butenethioic acid,S-[2-(acety: Highest concentration at Site (5) at (1.49). Not detected at other sites. 3-Butyn-1-ol: Highest concentration at Site (5) at (0.32). Not detected at other sites. Acetic acid,trifluoro-ethyle.: Highest concentration at Site (5) at (0.9). Not detected at other sites. Ethyl chloride: Highest concentration at Site (5) at (1.72). Not detected at other sites. 2-Isopropoxyethylamine: Highest concentration at Site (5) at (0.64). Not detected at other sites. 2-Fluoro-β-alanine: Highest concentration at Site (6) at (10.23). Not detected at other sites. Ethylamine: Highest concentration at Site (6) at (10.23). Not detected at other sites. Propane: Highest concentration at Site (7) at (1.41), while at Site (6) it was (0.32). Not detected at other sites. Furan,tetrahydro-2,5-dimethyl-: Highest concentration at Site (7) at (13.96). Not detected at other sites. Propanal, 2,2-dimethyl-oxime: Highest concentration at Site (7) at (17.63). Not detected at other sites. 2-Furanmethanamine, tetrahydro-: Highest concentration at Site (7) at (8.62). Not detected at other sites. 1-Propanamine, 3-propoxy-: Highest concentration at Site (7) at (1.93). Not detected at other sites. Ethanone, 1-(3-ethyloxiranyl-: Highest concentration at Site (7) at (1.12). Not detected at other sites. Pyrrolidine,3-methyl-: Highest concentration at Site (7) at (0.58). Not detected at other sites. Cyclododecanol,1-aminomethyl-: Highest concentration at Site (7) at (2.65). Not detected at other sites. Pyrimidine,4,6-dimethoxy-5-nitro-: Highest concentration at Site (7) at (12.36), while at Site (10) it was (0.10). Not detected at other sites.

1, 2-Benzenedicarboxylic, mo: Highest concentration at Site (7) at (6.72). Not detected at other sites. Ethanamine, 2-methoxy-: Highest concentration at Site (9) at (0.99). Not detected at other sites. Hydroperoxide, heptyl: Highest concentration at Site (9) at (5.52). Not detected at other sites. Glycine, ethylester: Highest concentration at Site (9) at (3.79). Not detected at other sites. 1-Butanamine,2-methyl-:

Highest concentration at Site (9) at (1.34). Not detected at other sites. 1-Hexanol, 6-amino-: Highest concentration at Site (9) at (2.92). Not detected at other sites. 2-Ethoxyethylamine: Highest concentration at Site (9) at (1.66). Not detected at other sites. Diethyl azodicarboxylate: Highest concentration at Site (9) at (6.98). Not detected at other sites. Propyne: Highest concentration at Site (9) at (2.10). Not detected at other sites. Silane: Highest concentration at Site (9) at (2.40). Not detected at other sites. Hexanenitrile, 6-amino-: Highest concentration at Site (9) at (1.63). Not detected at other sites. 2-Chloroethylamine: Highest concentration at Site (9) at (0.87). Not detected at other sites. Ethane, nitro-: Highest concentration at Site (9) at (2.00). Not detected at other sites. 2-Chloroethanol: Highest concentration at Site (9) at (1.68). Not detected at other sites. 1, 2-Ethanediol: Highest concentration at Site (9) at (1.81). Not detected at other sites. 3-Aminopropionitrile: Highest concentration at Site (9) at (1.90). Not detected at other sites. Isobutylamine: Highest concentration at Site (9) at (1.61). Not detected at other sites. Pyrimidine, 2, 6-dimethoxy-5-nitro-: Highest concentration at Site (9) at (0.72). Not detected at other sites. Adenosine, 2-methyl-: Highest concentration at Site (9) at (3.69). Not detected at other sites. 1,2-Ethanediol: Highest concentration at Site (10) at (0.12). Not detected at other sites. 2,4,6 (1H,3H,5H)-Pyrimidinetrione: Highest concentration at Site (10) at (1.78). Not detected at other sites. 2H-1, 4-Benzodiazepin-2-one, 7-ch: Highest concentration at Site (10) at (0.83). Not detected at other sites. Cyclooctasiloxane, hexadecamethyl-: Highest concentration at Site (10) at (0.93 µg/g). Not detected at other sites. Pentasiloxane, dodecamethyl-: Highest concentration at Site (10) at (0.82). Not detected at other sites. Heptasiloxane, 1,1,3,3,5,5,7,7,9...: Highest concentration at Site (10) at (2.63). Not detected at other sites. 1H-Indole-2-carboxylic acid, 6-(: Highest concentration at Site (10) at (1.09). Not detected at other sites. It was reported that the main sources of hydrocarbon compounds in the air are coming from human activities, such as fuel combustion, industries, waste from manufactories, and others. Some studies also revealed that the presence of hydrocarbon compounds in the air samples located in cities is mainly due to garbage fires, especially in countries that don't use or have waste treatment. In Libya, the waste and garbage of citizens in the cities don't have any treatment or recycling protocol; therefore, most of the cities' garbage is burned at locations near these cities. However, most of the dust in the air samples is coming from the garbage burners [2-5].

Conclusion

According to the results recorded in this study, different types and contents of hydrocarbons were detected in the air samples collected from different locations inside and around El-Baida city. The study declared that the main sources of these compounds are mainly from the burning of garbage in cities.

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Conflict

The authors provided that there is no conflict in the results recorded in this study.

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