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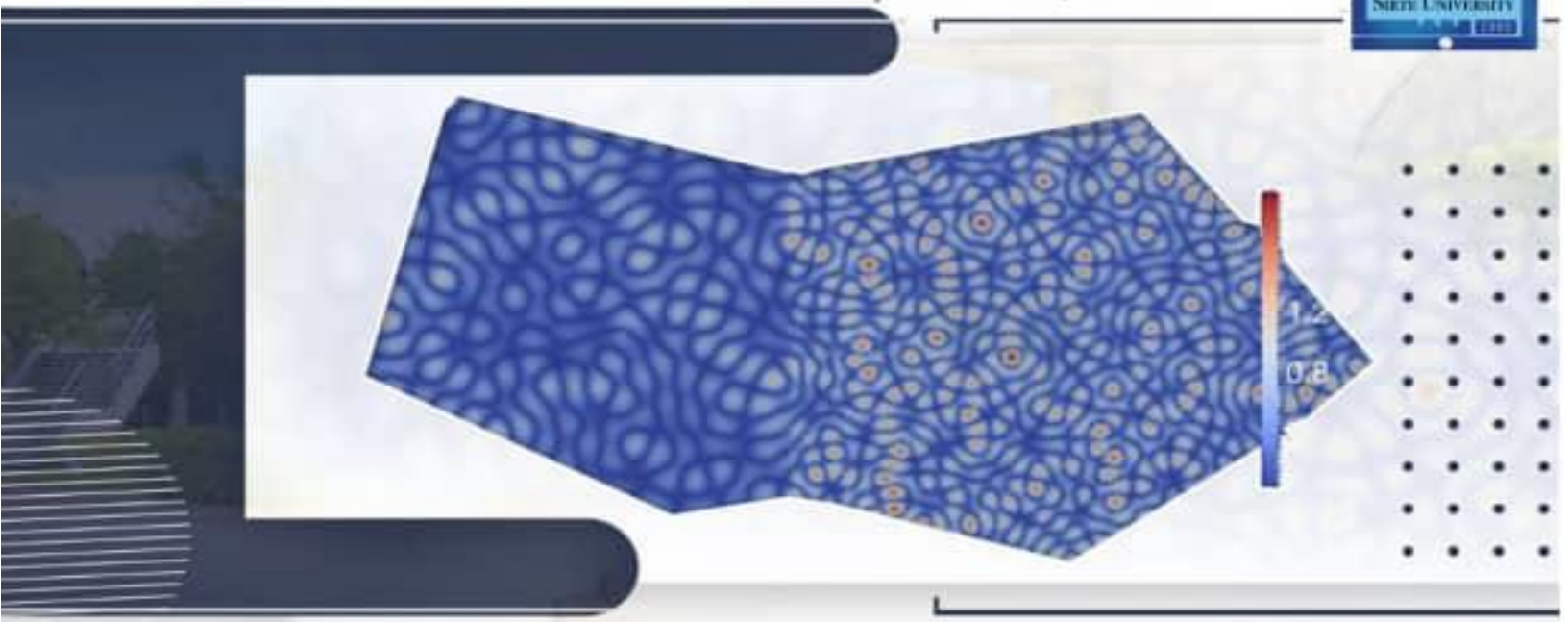

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Measuring the Content of 16 PAH in Plant (potato) from Bradford in the UK

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A B S T R A C T

The objective of this study was to determine the spatial distribution of the PAH (polycyclic aromatic hydrocarbons) concentrations in a sample of potatoes from Bradford, this objective will be achieved by solvent extraction and analysis of potato samples using gas chromatography with mass spectrometry (GC-MS). The potato samples were collected from four sites in the city of the Bradford-middle north of the United Kingdom. The exact location of each sample was recorded using a Global Positioning System (GPS). In site 1 the average concentration of Benzo[b]fluoranthene was (9.82 ng/g). This compound had the highest concentrations level of the 16 PAHs in all sites, while the average (1.023 ng/g) in site 2 of the compound with the low-value Pyrene. The total concentration of 16 PAHs range was between 50.87 -78.31 ng/g.

1. Introduction

Polycyclic Aromatic Hydrocarbons (PAHs) have been of increasing concern due to their ubiquitous presence in urban air. Some of these compounds have toxic, carcinogenic, and mutagenic properties (Abdel-Shafy and Mansour, 2016)

As a category of widely known carcinogenic compounds derived from incomplete combustion (IARC, 1983; Harvey, 1991), because of the transportation, storage, and use of crude oil and its products, petrogenic PAH sources are ubiquitous in cities. Storage tank leaks and the accumulation of tiny discharges of motor oil, gasoline, and other transportation-related substances are major sources of petrogenic PAHs (Abdel-Shafy and Mansour, 2016). Among the most important environmental pollutants are polycyclic aromatic hydrocarbons compounds (Dong et al., 1999).

Because diet is thought to be the primary source of human exposure to PAHs (Phillips, 1999), and vegetables are a basic food, scientists are interested in how much PAHs accumulate in vegetable production. Many studies have been conducted to investigate the uptake of PAHs by plants. (Wild et al., 1992; Voutsa and Samara, 1998; Kipopoulou et al., 1999)

PAH contamination was discovered in a variety of dietary categories, including vegetables. (Howard and Fazio, 1980).

It seems that gas emissions from fossil fuel combustion are the main way that PAHs accumulate in vegetables nearby, and this affects the PAH levels and profiles in those vegetables. (Kipopoulou et al., 1999)

The absorption of PAHs by vegetables can occur through the absorption of the leaves or roots, and their absorption is directly related to the nature of the PAH compounds, their physico-chemical characteristics and the physiological conditions of the plant. (Wang et al., 2011)

The PAH content of foliage is mainly correlated to ambient air. The relationship with soil PAH concentrations is not strong due to the relatively weak influence of root uptake mechanisms related to the low degree of soil/plant separation resulting from the lipophilic properties of PAH molecules. (Tuteja et al., 2011)

Direct contact between some leaf crops and contaminated soil can lead to increased levels of PAHs (Delschen et al., 1999). Vegetables usually reflect short-term changes in air pollution, while the soil is subject to long-term changes resulting from cumulative deposition (Jones, 1991).

Contaminants found in plants grown in cities usually come from previously contaminated soil or air pollution (Säumel et al., 2012; de Temmerman et al., 2015). It has

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been previously shown that the accumulation of elements and genotoxic effects due to air pollution are absorbed by the leafy vegetables in the UCG. (Amato-Lourenco et al., 2016a,b). To determine the spatial distribution of the PAH concentrations in sample of potatoes from Bradford, this objective will be achieved by solvent extraction and analysis of potato samples using gas chromatography with mass spectrometry (GC-MS).

2. Materials and Methods

a. Study Area

The potato samples were collected from an area in the city of Bradford, West Yorkshire. The exact location for each sample was recorded using a Global Positioning System (GPS), as shown in table (1).

Table 1: Coordinates of the potato sample locations from Bradford.

Coordinates for samples from Bradford	
East	**North**
413107	432166
414882	432141
416861	432127
417888	432137

b. Sampling and Sample Preparation

The sample preparation after being collected then transported to the laboratory, potatoes were washed with distilled water to remove surface dust and freeze-dried. Cut 5g skin of potato mixed with equal amount of anhydrous Na_2SO_4 after that Soxhlet extraction 6h with $CHCl_3$ then rotary evaporation to ~0.5 ml. The extraction evaporation to dryness under N_2 stream then redissolution in CH_3CN the samples are now ready to analysis GC-MS (Kipopoulou and Manoli 1999).

c. GC-MS Method

An Agilent technologies 7890A GC system with 5975c mass selective detector (MSD) was used to separate, identify and determine the concentrations of PAHs in soil extracts. 1µl of each sample extract was injected into a splitless injector at a temperature of 300°C. The samples were separated with a HP5 capillary column (30 mm ×0.25 mm × film 0.25 µm film). The initial oven temperature was at 40°C for 1 min, rising to 120°C at 25 °C/min, then to 160°C at 10°C/min, and finally to 300°C at 5°C/min, this final temperature was held for 15 min. The interface temperature was kept at 280°C. Helium was the carrier gas used at a constant flow rate of 1 mL/min. The 16 PAHs standards were analysed with a Selected Ion Monitoring (SIM) mode (Dong, 2012).

3. Results

By choosing the molecular masses of interest for each molecule, contamination analysis can be avoided. In fact, each PAH has a distinct mass that is well-known and documented in the literature (Dong, 2012), and if the retention duration is known, it is possible to choose which masses should be detected. In this investigation, the SCAN mode was used to analyze the 16 PAH standard in order to determine the retention times of each chemical of interest. The technique has been developed, as shown in table (2) below, with the specific masses and retention times of each PAH.

Table (3) shows the average concentration individual 16 PAH and total PAH level. The average concentration of Benzo[b]fluoranthene in site 1 was (9.82 ng/g). This compound had the highest overall concentrations level of the16 PAHs in all sites. while the average 1.023ng/g in site 2 of the compound with the low overall value Pyrene. The 16 PAHs levels range between 50.87 -78.31ng/g in potato samples were found to be more or less similar to other regions. Bishnoi et al. (2006) found 16 EPA PAH values in range of 59.78-128.47 ng/g in underground vegetables collected from various places of Mumbai city, India. Also, the result of this study was less similar 48-94 ng/g in root vegetables in a Greek (Kipopoulou et al. 1999).

Table 2: SIM parameter of MS for PAH analysis

Abbreviation	m/z	Rt [min]
NA	127, 128, 129	4-7
ACY	151, 152, 153, 154, 165, 166, 167	7-12
ACE		
FL		
PH	176, 178, 179	12-15
AN		
FLU		15-22
PY	101, 200, 202, 203 15-22	
BaA	226, 228, 229	22-25
CH		
BbF	125, 252, 253	25-33
BkF		

BaP		
IP	138, 134, 276, 277, 278, 279	33-46
DA		
BP		

Table 3: Average Concentration individual 16 PAH and total PAH level.

	Site1	Site2	Site 3	Site 4
Abbreviation Compound	Average [ng/g]	Average [ng/g]	Average [ng/g]	**Average [ng/g]**
NA	9.581	4.956	1.762	**2.874**
ACY	6..428	2.835	1.910	**2.293**
ACE	1.05	1.290	2.110	**2.495**
FL	4.349	3.469	2.798	**5.557**
PH	7.599	7.680	2.738	**6.147**
AN	5.614	2.937	1.814	**2.098**
FLU	1.600	1.170	3.832	**5.954**
PY	1.490	1.023	3.632	**5.185**
BaA	3.505	6.618	7.400	**1.411**
CH	2.997	4.099	5.866	**1.0578**
BbF	9.820	1.187	6.629	**1.528**
BkF	6.391	8.313	2.702	**1.294**
BaP	5.117	7.549	3.852	**1.738**
IP	8.316	4.029	2.155	**2.141**
DA	8.806	3.237	2.991	**2.136**
BP	2.080	1.168	3.572	**6.965**
Total PAH [ng/g]	78.315	61.56	55.763	**50.873**

4. Discussion

Table (4) presents a statistical comparison was made using Analysis of variance of the differences between the four study areas in order to assess whether these areas are significantly different in their PAH concentrations. The total concentration data for all PAHs combined, as well as the data for each individual compound separately, were analysed using one-way ANOVA with the individual sampled sites being the replicates within each study area, to determine whether data from the four areas

There are significantly different. Results are presented in Table (5). There are significantly different in individual PAH concentrations. The result of this test ($F = 4.65$, $df = 99$, $p = 0.01$) that indicated a strongly significant difference between the four areas

Table 4: Results from one-way Analysis of Variance calculations, testing for differences between the four study areas in Bradford, for individual PAH compounds and for the combined total PAH concentrations. Number of degrees of freedom are (2, 97) in all cases. Key to symbols: ns indicates $p>0.05$, * indicates $P<0.05$, ** indicates $P<0.01$, *** indicates $p<0.001$

PAH	All sites		
F-value Probability	Significance		
NA	17.8	0.0001	***
ACY	15.9	0.0001	***
ACE	29.8	0.0001	***
FL	30.7	0.0001	***
PH	16.4	0.0001	***
AN	29.1	0.0001	***
FLU	20.8	0.0001	***
PY	43.8	0.0001	***
BaA	50.4	0.0001	***
CH	70.4	0.0001	***
BbF	7.5	0.001	**
BkF	10.6	0.001	**
BaP	3.2	0.01	*
IP	15.4	0.0001	***
DA	9.8	0.001	**
BP	10.2	0.001	**

The total PAH concentration in table (4) showed values ranged between 50.87and 78.32 ng/g, all of which would be diagnosed as low by Dong (2012).

The total PAH compounds which showed a relative standard deviation (%RSD) greater than 10% were presented in table (4), 10% being an arbitrary threshold chosen to highlight that the compound has a comparatively high amount of variability.

The Shapiro-Wilk test indicated that these samples were no normally distributed in Bradford. For total PAH compounds a Grubbs' test was carried out to check for outliers. The Grubbs' test (G values which are less than the critical value 1.481 and therefore there is no outlier

for any compound. This means there were no other outliers within these compounds.

Table 5: Statistical analysis table for total concentration of the16 PAHs from all sites

All sites	
Mean ng/g	62
Range ng/g	50.87-78.32
Standard deviation SD	12
Relative standard deviation RSD (%)	19
Shapiro-Wilk test probability	0.364 ns
Grubbs' test statistic (G)	0.898ns

5. Conclusions

To sum up above it is probably the large variability between individual results within a study area, as noted above, that lead to differences between means being able to be shown to be statistically significant. While the data had a one-way ANOVA result (F = 4.65, df = 99, p = 0.01) that indicated a strongly significant difference between the four areas.

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Conflict of Interest: The author declares that there are no conflicts of interests.

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