



Level of polycyclic aromatic hydrocarbon compounds in Celery, and Okra in the local markets of Basra , Iraq.

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Abstract:

levels of compound polycyclic aromatic hydrocarbons (PAHs) in (okra and celery) that were gathered from a number of Basra region marketplaces, Half of the samples were cleaned with water in order to assess the effect of this method on lowering PAHs level. gas chromatography- Mass spectrometry were used to determine the amounts of PAHs in samples. The findings indicated highest concentration of total PAHs was found in celery (6.9 μ g/g) tested from Basra market, followed by okra (6.26 μ g/g) collected from the same market, and the lowest concentration of total PAHs Recorded in okra sample (0.28 μ g/g) from Ashar market. Washing with water decreased PAHs levels in samples.

When samples were washed with tap water, the concentration of total and carcinogenic PAHs in celery from Basra Market was found to be lower (3 μ g/g), and removal efficiency was found to be 56.5%. Similarly, okra from Basra Market was found to have a corresponding reduction (0.9 μ g/g), with removal efficiency being found to be 85.6%. It has been proposed that a comprehensive vegetable washing plan may reduce the daily consumption of foods containing PAHs.

Key words: polycyclic aromatic hydrocarbons , fruits , washing , Iraq.

Introduction

Hydrophobic chemical molecules with two or more aromatic rings are known as polycyclic aromatic hydrocarbons, or PAHs. They are known to be created during incomplete combustions as a result of high moisture content,

improper temperature, and inadequate oxygen content. The volatile chemicals known as PAHs have a strong adsorption tendency on organic materials and a low solubility in water. (Amini *et al.*, 2014; Garcia *et al.*, 2014) Humans, animals, and plants are frequently exposed to chemical

combinations that operate through various methods. (Al-Hejuje ,2014; Al-Saad *et al.*,2017). Because of their extreme toxicity, the US Environmental Protection Agency (EPA) has classified 16 PAHs as chemicals of concern. A compound's carcinogenicity is determined by its molecular weight. While polycyclic aromatic hydrocarbons (PAHs) with three or more rings are considered high-molecular-weight and carcinogenic, those with two or three rings are considered low-molecular-weight and, hence, less hazardous (Jia *et al.*, 2018) Lower-molecular-weight PAHs are usually found in the vapor phase, whereas higher-molecular-weight PAHs can escape in both the vapor and particle phases. (Mohammed *et al.*, 2019). When released into the environment, polycyclic aromatic hydrocarbons (PAHs) can travel via the air, water, sediments, soil, and plants, infecting both terrestrial and aquatic creatures. Thus, it's feasible that high concentrations of PAHs are present in human meals. (Al-Aboodi,2020). The general population has been exposed to more carcinogens, especially PAHs, as a result of domestic, industrial, and natural processes. (Al-Khatib ,2008). Humans are exposed to PAHs through both dietary and non-dietary sources, including skin contact and inhalation. Eating is the primary way that one is exposed to them. (Famiyah *et al.*, 2021). The presence of polycyclic aromatic hydrocarbons (PAHs) in various food types is mostly caused by

environmental pollution, food processing, and food packaging. The amount of PAHs present varies depending on the source of the contamination Vegetables and fruits cultivated nearby have been shown to have different levels and profiles of PAHs due to the emissions from industrial and vehicle traffic(Paris *et al.*,2018). However, PAHs can be created during food processing if fuel is burned only partially, as in the case of smoking or drying food. (Onyedikachi *et al.*,2019) The product itself, the aromatic hydrocarbon, and the surroundings surrounding the crops can all have a significant impact on the amount of PAHs. The concentration of PAHs in products grown near roadways or in urban areas is generally higher than that of products grown in rural regions. (Abdel-Shafy and Mansour, 2016).. The objective of this study is to determine the levels of polycyclic aromatic hydrocarbons (PAHs) in edible fruits and vegetables from Iraq and how different treatments, including washing, impact these levels.

Materials and Methods

Sample collection

To find the PAH contents, 20 vegetable samples from two distinct species (okra and celery) were randomly gathered between August 2022 and May 2023. The districts where food was dispersed over the several Basra regions (AL-Basra Market, Al-Ashar Market, and Al-Zubair

Market) were where the samples were taken from. Every sample was kept at a low temperature until analysis.

The findings were verified for accuracy through the use of quality assurance techniques and

precautions. All processing materials were rinsed with water and distilled water to possibly remove PAH contamination.

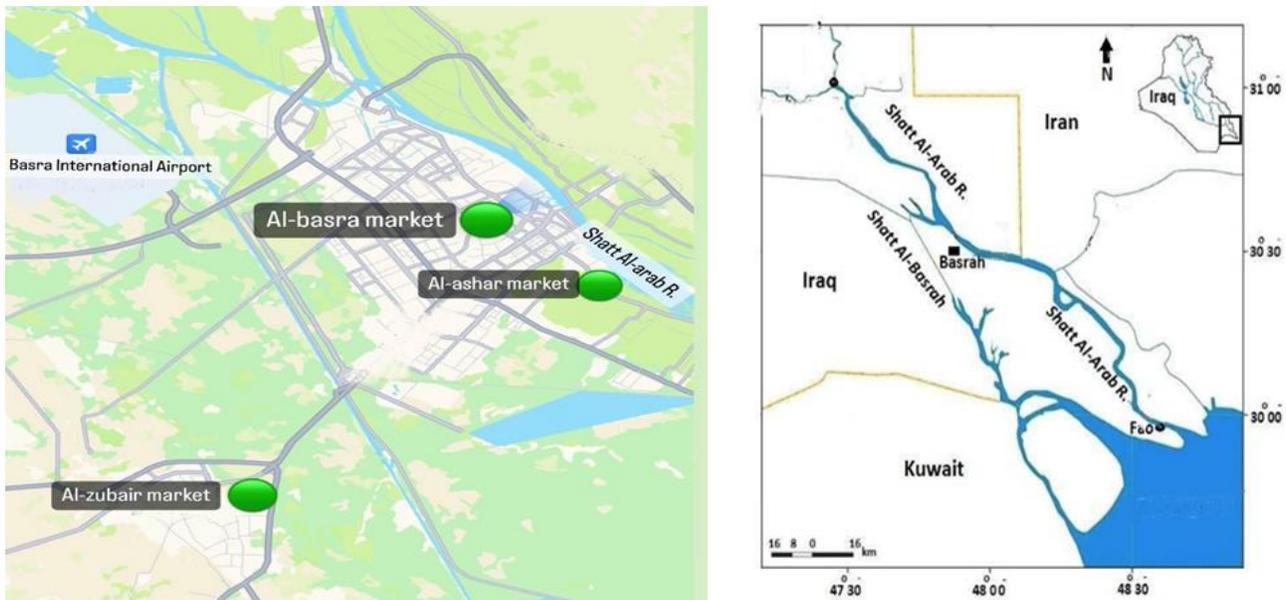


Figure 1. main Markets in Basrah, Iraq

Laboratory work:

Experimental of PAHs detoxification

PAHs detoxification by washing

Half of Samples (celery, and okra) were separately washed with water from the faucet. Samples that were naturally polluted and had high levels of PAHs underwent the washing process.

Chemical analysis:

The procedure described by Grimalt and Oliver (1993) was used to extract hydrocarbon components from fruits and vegetables that had

been carefully examined. 5g of pulverized and dried samples were weighed, put in the extraction thimble, and then moved to the Soxhlet apparatus for extraction. added 100 ml of a methanol:benzene (1:1, v/v) solvent combination, and the extraction process was carried out for 24 hours at 35 degrees. After adding 80 ml of the methanol:benzene (1:1 v/v) mixture, To initiate the saponification process, 20 ml of methanolic potassium hydroxide solution (4N MeOH(KOH)) were added. For two hours, the saponification procedure was

completed. The extract was then allowed to cool before being moved to a separatory funnel and filled with 50 ml of hexane. After giving the mixture a good shake, it was allowed to settle. There were two separate layers visible as the mixture stabilized. The dissolved hydrocarbons and hexane were found in the upper layer, and the fatty acids were found in the bottom layer. The upper layer was filtered using a column, while the lower layer was ignored. Glass wool was packed at the bottom, then deactivated silica gel, deactivated alumina, and anhydrous sodium sulfate at the top. To collect the aromatic portion, add 25 ml of benzene after using 25 ml of hexan to collect the aliphatic hydrocarbon compounds..

Statistical analysis

Statistical analysis of variance (ANOVA) was performed on the study data, and the minitab program version 18 was utilized to calculate the least significant difference value between stations and between the means of the washed and unwashed samples at ($P < 0.05$).

Results and Discussion

It was established what the concentrations of PAHs were in the okra and celery that were gathered from different marketplaces in the Basra Urban Region. The outcome shows that

there are significant differences in the amounts of PAHs found in the vegetable samples that were collected.

The results indicated that the samples of celery and okra did not contain acenaphthylene, acenaphthene. Conversely, mean quantities of benzo(ghi)perylene, and fluorene were found in the okra sample. According to the data gathered, celery seemed to have the highest quantity of carcinogenic and total PAHs.

These results are consistent with those published by Abou Arab (2014), who showed that the high surface area of spinach led to an accumulation of PAHs in the air. Moreover, According to Tuteja et al. (2011), leafy vegetables have higher levels of PAH contamination because they have a bigger surface area than subterranean plants, which traps higher amounts of PAHs.

he data showed that three- to four-ring PAHs predominated in each sample collection. The primary causes of air pollution that lead to PAH contamination in the atmosphere are motor vehicle or industrial emissions. The several vegetables under investigation have varying mean amounts of PAHs. Celery shows higher levels of total and carcinogenic PAHs than okra throughout growth because of its increased surface interaction with the surrounding air.

Polycyclic aromatic hydrocarbons in celery**Table 2: Polycyclic aromatic hydrocarbons in celery (µg/g)**

PAHS	Markets					
	al-zubair		AL-Basrah		Al-ashar	
	Un Washed	Washed	Un Washed	Washed	Un Washed	Washed
Naphthalene	0.7	0.7	0.8	0.7	0.1	0.1
2-methyl naphthalene	0.7	0.7	0.8	0.7	0.25	0.1
1-methyl naphthalene	0.4	0.4	0.5	0.4	0.7	0.11
Acenaphthlene	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND
Phenanthrene	0.1	0	0.5	0	0.04	0
Anthracene	2	1.1	1.6	0.6	0.04	0
Fluoranthene	ND	0	0	0	0.05	ND
Pyrene	0.6	0.1	0.5	0	0.1	0
Benzo(a)Anthracene	0	0	0.2	0	0	0
Chrysene	0.5	0.1	0.3	0.3	0	0
Benzo(b)fluoranthene	0.2	0.1	0.3	0.1	0	0
Benzo(k)fluorescence	0.2	0.1	0.3	0.1	0	0
Benzo(a)pyrene	0.3	0	0.3	0.1	0.1	0.08
Indo(1,2,3-cd)Pyrene	0.1	0.1	0.3	0	0	0
Dibenz(a,h)anthracene	0.1	0.1	0.2	0	0	0
Benzo(g,h,i)perylene	0.3	0	0.3	0	0	0
Total	6.2	3.5	6.9	3	1.38	0.39
LPAHs	2.3	0.6	2.7	0.6	0.25	0.08
HPAHs	3.9	2.9	4.2	2.4	0.54	0.9
L/H	0.59	0.21	0.64	0.25	0.46	0.089
Phenanthrene/Anthracene	0.05	0	0.31	0	1	-
Fluoranthene/Pyrene	0	0	0	0	0.5	-

ND: (not detected)

LPAHs: Low molecular weight polycyclic aromatic hydrocarbons

HPAHs: High molecular weight polycyclic aromatic hydrocarbons

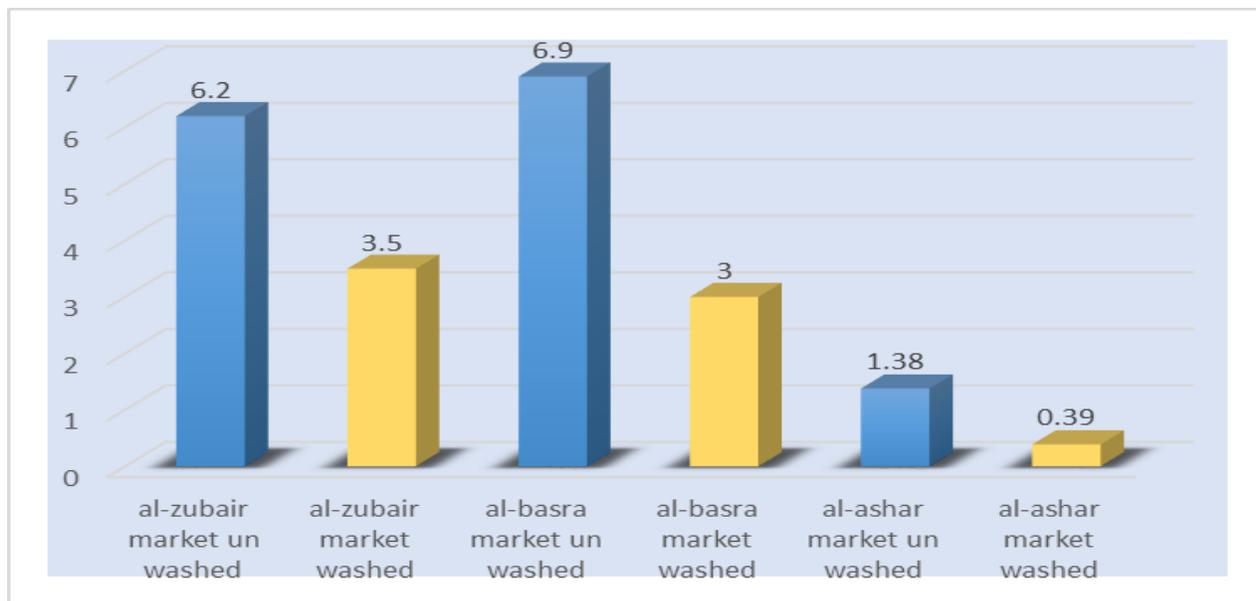


Figure 2. Mean levels (ng/g) of PAHs and reduction percentage in celery as affected by washing using tap water

The highest total concentration of PAHs in celery was recorded at Al-basra market 6.9 ng/g. On the other hand, the lowest total concentration of PAHs was recorded at Al-Ashar market, which was 0.39 ng/g.

The results of the statistical analysis using ANOVA test showed significant differences at the probability level ($P \leq 0.005$) between the markets, and no significant differences at the probability level ($P > 0.005$) between the washed and un washed samples in the total concentration of PAHs in celery. Celery has a

composite source, with a majority of biogenic origin and a minority of petrogenic origin, according to the ratio of LPAHs to HPAHs. It was determined that celery's phenanthrene to anthracene ratio was less than 10, which is conclusive proof that celery comes from pyrogenic sources. (Zakaria and others, 2002). ratio of Floranthene to Pyrene indicates that the source of PAHs in celery samples is Pyrogenic, which is consistent with a study conducted by Zohir (2006).

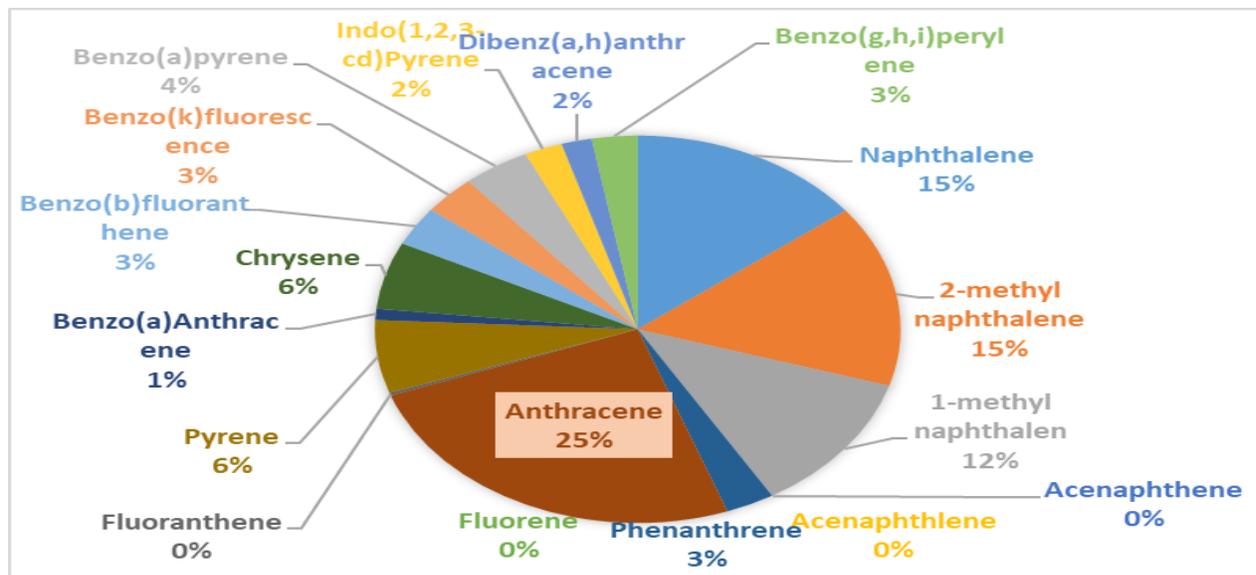


Figure 3. The percentage of polycyclic aromatic hydrocarbons (PAHs) in celery.

The results clearly show that all celery samples contain the chemical naphthalene, which is categorized as a PAH that could lead to cancer in humans (Yost *et al.*, 2021). The substance benzo(a)pyrene, which is produced by incomplete fuel combustion rather than by live organisms, was found in amounts in all of the samples, according to the data. Numerous laboratory investigations have confirmed its carcinogenic and mutagenic effects, making it one of the most harmful PAHs for human

health. Results showed that acenaphthylene, acenaphthene, and Fluorene were not detected in celery samples. Results showed that indeno(1,2,3-cd)pyrene and benzo(ghi)perylene, were detected in celery.

The findings show that large amounts of HPAHs compounds were present, pointing to a pyrogenic source. This does not, however, rule out the presence of LPAHs compounds, which point to a petrogenic origin.

Table3: The removal percentage after washing in celery

markets	The removal percentage after washing
AL-Zubair market	%43.5
AL-basra market	%56.5
AL-Ashar market	%71.7
Overall removal rate	%57.2

The outcomes also demonstrated how well the washing procedure reduced the overall PAH levels in all of the celery samples, which is in line with a 2014 study by Abou Arab that discovered the washing procedure to lower PAH concentrations. The elimination shows that

airborne pollutants that settle on the surface of vegetation are the source of extremely high amounts of PAHs. These results support the findings of Lin and Zhu (2005), who showed that the vast surface area of tea leaves allowed PAHs to collect from the air.

Polycyclic aromatic hydrocarbons in Okra:

Table 4: Polycyclic aromatic hydrocarbons in Okra (µg/g)

PAHS	Markets					
	Al-zubair		AL-Basrah		Al-ashar	
	Un Washed	Washed	Un Washed	Washed	Un Washed	Washed
Naphthalene	0.3	0.2	0.2	ND	0.18	0.08
2-methyl naphthalene	0.3	0.2	0.2	ND	ND	ND
1-methyl naphthalene	0.2	0.1	0.1	ND	ND	ND
Acenaphthlene	ND	ND	ND	ND	ND	ND
Acenaphthene	0	0	0	0	0	0
Fluorene	0.08	0	0	0	0	0
Phenanthrene	0.1	0.11	0.17	ND	0.22	0.1
Anthracene	0.13	0.08	0.19	ND	0.25	0.1
Fluoranthene	0.2	0.09	0.1	ND	0.09	ND
Pyrene	0.2	0.11	0.1	0	0.03	0
Benzo(a)Anthracene	0.1	0	0.1	0	0	0
Chrysene	0.3	ND	0.2	ND	0	ND
Benzo(b)fluoranthene	0.2	0.1	0.3	0	0	0
Benzo(k)fluorescence	0.3	0.09	0.3	0.2	0	0
Benzo(a)pyrene	0.12	0	1.3	0.1	0.1	ND
Indo(1,2,3-cd)Pyrene	1.2	0	1	0.3	ND	0

Dibenz(a,h)anthracene	1.2	ND	1	0.3	0	ND
Benzo(g,h,i)perylene	1.2	0	1	0	0	0
Total	6.13	1.08	6.26	0.9	0.87	0.28
LPAHs	5.02	0.39	5.4	0.9	0.22	0
HPAHs	1.11	0.69	0.86	0	0.65	0.28
L/H	4.52	0.57	6.28	0	0.34	0
Phenanthrene/Anthracene	0.77	1.375	0.89	0	0.88	1
Fluoranthene/Pyrene	1	0.82	1	0	3	0

ND: (not detected)

LPAHs: Low molecular weight polycyclic aromatic hydrocarbons

HPAHs: High molecular weight polycyclic aromatic hydrocarbons

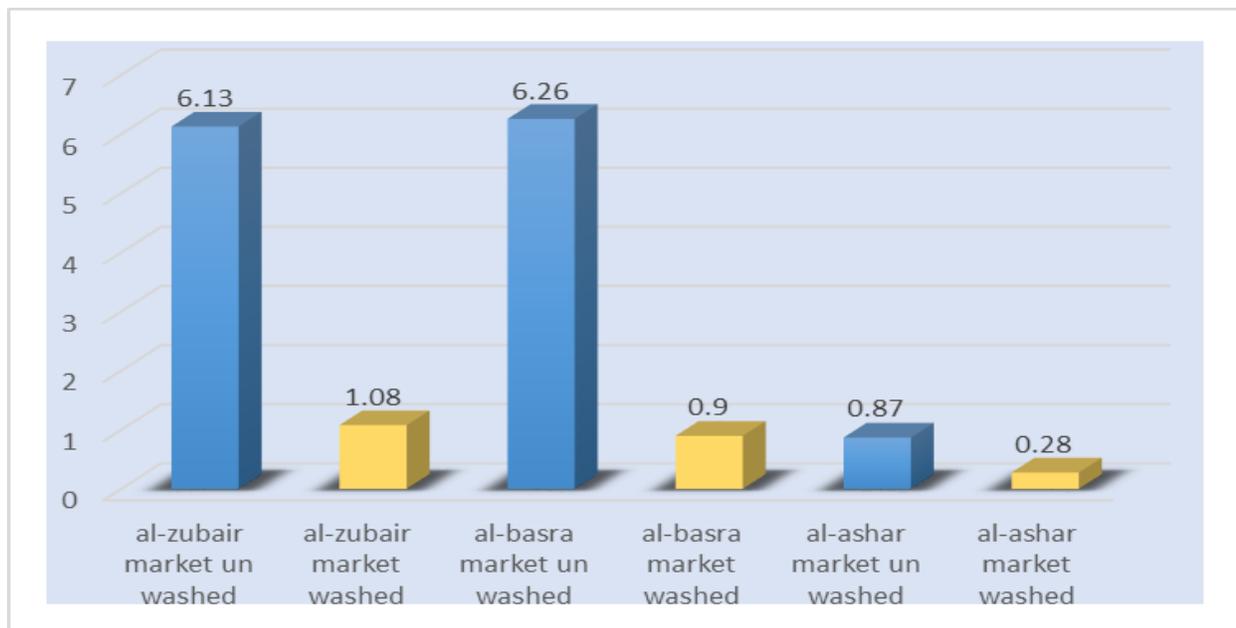


Figure 4. Mean levels ($\mu\text{g/g}$) of PAHs and reduction percentage in Okra as affected by washing using tap water

The highest total concentration of PAHs in okra was recorded at Al-basra market $6.26 \mu\text{g/g}$. On the other hand, the lowest total concentration of

PAHs was recorded at Al-Ashar market $0.28 \mu\text{g/g}$.

The results of the statistical analysis using the ANOVA test showed no significant differences

at the probability level ($P > 0.005$) between the markets, and no significant differences at the probability level ($P > 0.005$) between the washed and unwashed samples in the total concentration of PAHs in okra. The ratio of LPAHs to HPAHs in okra indicate that the source is shared source, biogenic origin, and petrogenic origin.

The ratio of phenanthrene to anthracene in okra was determined and found to be less than 10,

giving clear evidence that its source is pyrogenic.

The ratio of Floranthene to Pyrene ranged from 3 in ashar market sample to 0.82 in zubair market sample. This shows that the source of PAHs in okra samples is both Pyrogenic and Petrogenic (Zakaria et al.2002).

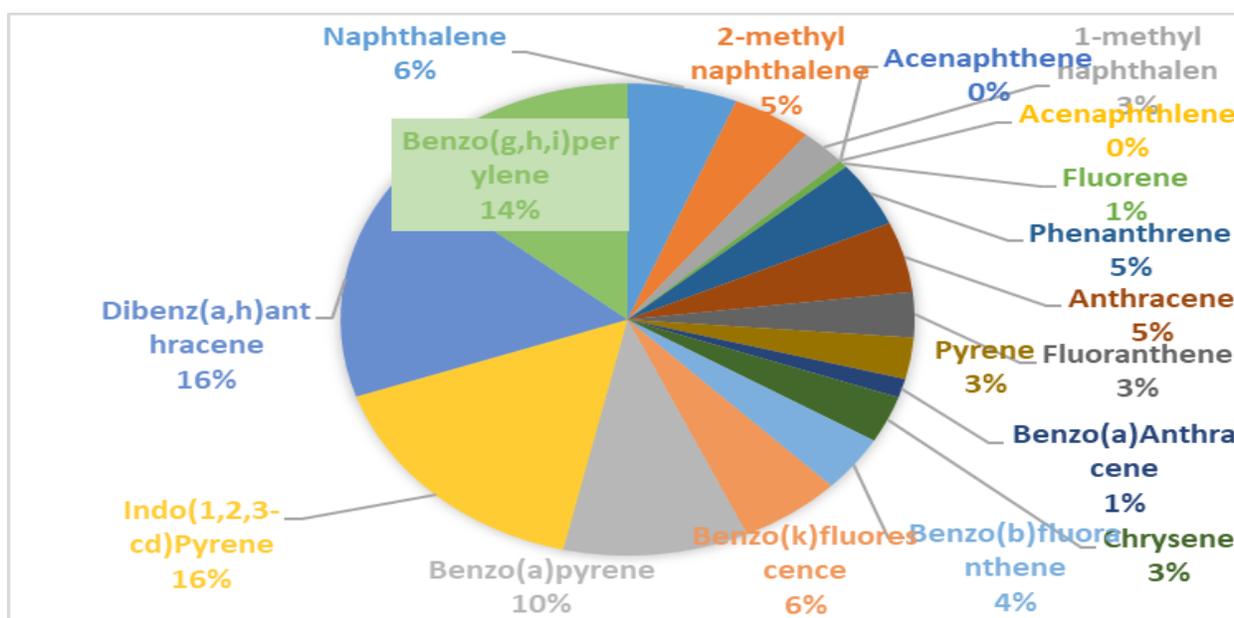


Figure 5. The percentage of polycyclic aromatic hydrocarbons (PAHs) in Okra.

The results clearly show that all of the okra samples contain the chemical naphthalene, which is categorized as a PAH that may cause cancer in humans. (Yost et al.2021). The results showed that indeno(1,2,3-cd)pyrene and Dibenz(a,h)anthracene recorded the highest total PAHs concentration, while the compound Fluorene recorded the lowest total

concentration. acenaphthylene, acenaphthene, were not detected in okra samples, Fluorene was detected in okra samples at low levels. The results indicate that HPAHs compounds showed up at high concentrations, indicating a pyrogenic source. However, this does not exclude the presence of LPAHs compounds, which indicate a petrogenic source.

Table5: The removal percentage after washing in okra

markets	The removal percentage after washing
AL-Zubair market	82.3%
AL-basra market	85.6%
AL-Ashar market	67.8%
Overall removal rate	78.5%

The outcomes also demonstrated how well the washing procedure reduced the overall levels of PAHs in all of the okra samples, which is in line with a 2014 study by Abou Arab that discovered the washing procedure lowered PAH concentrations. The elimination % shows that airborne pollutants that settle on the surface of vegetation are the source of extremely high amounts of PAHs. These results support those of Bishnoi and colleagues (2006).

Conclusion

For every sample that was examined, the concentrations of the majority of PAH chemicals have been noted; this is regarded as a strong indicator of the existence of these compounds, particularly benzo(a)pyrene and Naphthalene, Moreover, washing vegetables has made a significant contribution to lowering the amounts of these substances. The sources of pollution were primarily pyrogenic, indicating the impact of oil operations in the province.

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