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Risk Assessment of Lead in Egyptian Vegetables and Fruits from Different Environments

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Abstract**—**Lead being a toxic heavy metal that mankind is exposed to the highest levels of this metal. There are different sources of environmental pollution with lead as lead alkyl additives in petrol and manufacturing processes. The contaminated atmosphere in urban and industrial areas by lead in Egypt may lead to the contamination of foods beside the other different sources. The present investigation studied the risk assessment of lead in some Egyptian edible vegetables and fruits collected from different environments in Greater Cairo Governorate, i.e. industrial, heavy traffic and rural areas. A total of 325 leafy and fruity vegetables and fruits samples belonging to 11, 6 and 4 different species, respectively were randomly collected from markets of the three main models. Data indicated the variation of lead levels in different three areas. The highest levels of lead were detected in the samples collected from industrial and traffic areas. However, the lowest levels were found in the rural areas. It could be concluded that determination of lead levels in foods from different localities and environments at regularly is very important.

Keywords**—**Heavy metals, Lead, Vegetables, Fruits, Environments.

I. Introduction

LEAD metal is widely dispersed in the environment and may causing contamination of foods. There are different sources of lead contamination in the environment. The first one is lead alkyl additives in petrol which combusted and emitted into the atmosphere causing contamination in roadside, soil, air, [1], [2]. Manufacturing processes, incineration of refuse and combustion of coal, is also other sources contribute to lead in the atmosphere; hence it is not surprising that lead levels are highest in area of intense industrialization [3]-[5]. The levels of lead in the atmosphere of Egyptian industrial and urban areas were higher than the levels in some other countries [4], [6]. The authors reported that the annual mean concentration of lead exceeded both the Egyptian Standard [7] WHO air quality standard [8]. As a consequence of environmental pollution, the contaminants may enter the food chain with the other sources as water and soil. On the other hand, vegetables and fruits grown near highways or downwind of industrial plants may contain lead.

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Vegetables and fruits absorb lead from the soil [9], contaminated irrigation water [10], and polluted air. Uptake and accumulation of lead by plants may follow two different paths i.e., through the roots and foliar surface [11]. The uptake of metal from the soil depends on different factors of its solubility in the soil, soil pH and plant growth stages [12]. There are to report indicating that some species of plants may accumulate specific metals causing a serious health risk of human when plants based foodstuff are consumed [13].

Accurate determination of lead in foodstuffs is important since intakes of even low concentrations of leading can cause serious toxic effects. So, various concentrations of lead were detected in different types of foods in Egypt [14]-[17] and also in other countries [18]-[21].

An abundance of vital minerals protects against toxic metals. Vital minerals compete with toxic metals for absorption and utilization in enzymes and other tissue structures. However, when food is low in essential minerals, the body absorbs and makes use of more toxic metals. Toxic metals may also replace other substances in other tissue structures. These tissues, such as the arteries, joints, bones and muscles, are weakened by the replacement process [22]. On the other hand, accumulation of lead produce damaging effects on the hematopoetical, hematic, renal and gastrointestinal systems [23]. In addition, lead has been associated with various forms of cancer, nephrotoxicity, central nervous system effects and cardiovascular diseases in human [24], [25]. Toxicity of lead is closely related to age, sex, route of exposure, level of intake, solubility, metal oxidation state, retention percentage, duration of exposure, frequency of intake, absorption rate as well as mechanisms and efficiency of excretion [26]. In addition, the inhalation of lead can permanently lower intelligence quotients (IQ), damage emotional stability, cause hyperactivity, poor school performance and hearing loss [27].

During the last decades, the increasing demand of food safety has stimulated research regarding the risk associated with consumption of contaminated foods [28]. The aim of the present study was to evaluate the concentrations of lead in some foods from different Egyptian environments, in addition the distribution pattern of lead among the leafy and fruity vegetables.

II. Materials and Methods

A. Materials

1. Chemicals and Reagents

Stock standard solution (1000 mg/L) of lead (pb) was purchased from Merck (Merck, Darmstadt, Germany). Concentrated nitric acid at high grades (BDH chemical LTD) was also purchased. De-ionized water from Milli Q water purification was used.

2. Food Samples

A total of 155 leafy vegetables samples belonging to 11 different species (molokhia, parsley, coriander, dill, leek, garden rocket, spinach, Egyptian mallow, radish, celery and lettuce), 100 fruity vegetables belonging to 6 different species (green peas, green pepper, tomatoes, potato tubers, eggplant and cucumber) and 70 fruit samples belonging to 4 different species (grapes, guava, peaches and apricots) were randomly collected from three main models represent different environments in Great Cairo (Egypt), i.e., industrial (Shoubra El-Kheima and Helwan), heavy traffic (Faysal), and rural (near cultivated lands) areas during the period of 1/5/2010 to 1/11/2012.The collected sample's numbers during this period represent each area. The samples (3kg for each foodstuff) were quite representative since the districts from where foodstuffs were scattered throughout the different environments in Great Cairo, Egypt. Sub-samples (1kg, each) was taken at random from the composite sample and processed for analysis by the dry-ashing method. Lead contents were determined in all sample parts without any processes of washing or peeling.

B. Methods and Procedures

1. Test Principle

Lead is extracted from different commodities according to the methods of [29]. A dry ashing method was used for the destruction of organic matter. The ashed samples were dissolved in acidic de-ionized water, and lead contents were recorded by atomic absorption spectrophotometer at maximum absorbance obtained at wavelength 217.0 nm from the Pb cathode lamp.

2. Sample Preparation

The different weights of samples were homogenized separately and 3-5 g of the fresh homogenate was weighed into crucibles and dried in an oven at 100-110°C overnight (~16h.). Dried samples were ashed in a muffle furnace at 500-550°C. The ashed samples were cooled to room temperature and dissolved in 1mL 10% (v/v) nitric acid and then completed to a definite volume with de-ionized water.

3. Determination (Instrumentation)

The sample solutions were subsequently measured for lead as fresh weight basis using PG-990 atomic absorption spectrophotometer (PG Instruments LTd) with flame atomization (air-acetylene), equipped with a 10 cm burner and a deuterium lamp for back ground correction. Maximum absorbance was obtained by adjusting the cathode lamp at the proper wavelength (217.0 nm). The other analytical parameters were; bandwidth, 0.4 nm; filter factor, 1.0; lamp current, 5.0 ma; integration time, 3.0 sec; background, D2/SR and flame setting, oxidizing blue.

4. Method's Validity

a. Quality Assurance

Quality assurance procedures and precautions were carried out to ensure reliability of the results. All materials used for processing were screened for possible lead contamination. Acidic-cleaned volumetric flasks and other glassware is soaked in a soapy solution (2% solution detergent) for 24hr., then rinsed and soaked in 10-15% nitric acid for 48hr., then rinsed with ultrapure water and dried under clean conditions. Ultrapure water was used throughout the study. The samples generally carefully handled to avoid contamination.

b. Recovery and Detection Limits

Recovery results refer to complete method of reported before with different concentrations (0.1, 0.2 and 0.4 mg/kg) of lead in some types of leafy and fruity vegetables as well as fruit samples in this investigation were studied. The recovery of lead in fortified samples was ranged between (96.0 to 96.5), (94.0 to 95.0) and (98.0 to 99.0%) with leafy vegetables, fruity vegetables and fruits, respectively. Detection limit of lead was calculated and recorded which was 0.012 mg/L with sensitivity of 0.08 mg/L.

C. Statistical Analysis

The data obtained from this study was statistically subjected to analysis of variance (ANOVA) and means separation according to [30]. The least significant difference (L.S.D) value was used to determine significant differences between means and to separate means at ($p \leq 0.05$) using SPSS package version 15.0.

III. Results

Concentration of lead in different types of vegetables and fruit samples which collected from industrial, traffic and rural areas were determined and presented in Table I. Data proved that lead levels in the samples are quite variable among the three areas. Analysis of variance revealed that highly significant differences ($p \leq 0.05$) of lead contents was observed between the concentration of lead in most different plant samples of industrial areas compared with the other two areas as molokhia, garden rocket, green pepper, tomatoes, potato tubers, guava and apricot, which recorded mean values of 6.7917, 6.4330, 2.2749, 2.5355, 1.3541, 2.7337, and 2.5144 mg/kg, respectively. However, the highest level (2.1050 mg/kg) of spinach was detected in traffic areas. On the other hand, no significant differences ($p \geq 0.05$) between the other collected samples of both industrial and traffic areas were detected. Regarding to the rural area samples, data indicated that leads levels in their samples were the lowest compared with the other two areas.

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TABLE I
LEAD CONTENTS (MG/KG) IN VEGETABLE AND FRUIT SAMPLES FROM INDUSTRIAL, TRAFFIC, AND RURAL AREAS DURING THE PERIOD OF 2010 TO 2012

Foodstuffs	Concentrations (mg/kg)						LSD at 5%
	Industrial areas		Traffic areas		Rural areas		
	Mean± SD	Average	Mean± SD	Average	Mean± SD	Average	
1- Molokhia	6.7917^{a}±0.80	1.9593 -28.9790	3.9891^{b}±0.79	1.0492 - 7.0030	1.8332^{c}±0.40	0.2580 - 6.6427	1.76
2- Parsley	3.1424^{a}±0.08	0.4228 - 6.4566	2.4382^{a}±0.67	0.1956 - 6.0742	1.3638^{b}±0.02	0.2219 - 3.2153	0.95
3- Coriander	3.0393^{a}±0.18	0.4004 - 6.6027	2.2125^{a}±0.45	0.3784 - 4.6354	1.2975^{b}±0.78	0.2241- 3.0516	0.91
4- Dill	4.2777^{a}± 1.07	2.6488 - 6.5461	4.1715^{a}± 0.84	3.0246 -5.5489	1.9524^{b}±0.83	1.0682 - 3.7709	0.69
5- Leek	3.9402^{a}±0.73	1.2140 - 6.2360	3.6223^{a}±0.84	1.0155 - 7.3052	1.8408^{b}±0.73	1.0130 - 3.7709	1.16
6- Garden rocket	6.4330^{a}±0.51	1.8801 - 11.0002	4.3653^{b}±0.43	2.0511- 7.3286	1.8759^{c}±0.62	1.1667 - 3.5825	1.16
7- Spinach	1.8294^{b}± 0.60	1.2206 - 2.6611	2.1050^{a}± 0.19	2.0452 - 2.2406	1.4404^{c}±0.52	1.0221 - 2.0142	0.82
8-Egyptian Mallow	1.3544^{a}± 0.47	0.8692 - 2.0042	1.3448^{a}± 0.46	1.0142 - 2.0787	1.2720^{b}± 0.47	1.0485 - 1.4362	0.74
9- Radish	1.0744^{b}±0.24	0.8823 - 1.4599	1.4287^{a}±0.51	0.9635 - 2.1232	1.2457^{ab}±0.48	1.0014 - 2.1003	0.72
10- Celery	1.0127^{b}±0.60	0.5078 - 2.0040	1.2605^{a}±0.31	0.8720 -1.6752	1.0203^{b}±0.02	1.0102 - 1.0362	0.64
11- Lettuce	1.2979^{ab}±0.59	0.6604 - 2.0118	1.1951^{b}±0.25	1.0556 - 1.6380	1.3297^{a}±0.44	1.0066 - 2.0006	0.68
12- Green peas	1.6464^{a}±0.05	0.0650 - 3.9190	1.4509^{c}±0.15	0.1470 - 4.3120	0.6034^{b}±0.09	1.0026 - 1.2338	0.87
13- Green pepper	2.2749^{a}±0.67	0.2628 - 5.6080	1.5449^{ab}±0.81	0.3528 - 2.8724	0.9100^{b}±0.82	0.1490 - 2.9627	0.88
14-Tomatoes	2.5355 ^{a}±0.43	0.6927 - 41.1700	1.8335^{b}±0.88	0.4926 - 3.4765	0.9867^{c}±0.53	0.2272 - 2.0152	0.46
15- Potato tubers	1.3541^{a}±0.46	0.6352 - 2.3974	0.6818^{b}±0.75	0.0444 - 2.0633	0.5519^{b}±0.07	0.0128 - 1.6025	0.35
16- Eggplant	1.2494^{ab}±0.53	0.4362 - 0.9098	1.3869^{a}±0.91	0.6028 - 1.0058	1.2188^{b}±0.44	0.5589 - 0.9101	0.63
17- Cucumber	1.2494^{ab}±0.53	0.8806 - 2.1662	1.3869^{a}±0.91	0.8502 - 3.0043	1.2188^{b}±0.44	1.0033 - 2.0102	0.63
18- Grape	1.9868^{a}±0.12	0.6698 - 5.7930	1.7050^{a}±0.55	0.7955 - 2.801	0.9073^{b}±0.40	0.340 - 2.0420	0.49
19- Guava	2.7337^{a}±0.53	1.0373 - 8.1050	1.8302^{b}±0.09	0.279 - 3.7184	0.9307^{c}±0.04	0.3700 - 2.4446	0.56
20- Peaches	1.2314^{ab}±0.57	0.1211 - 2.4656	1.3997^{a}±0.58	0.5383 - 2.4893	1.0024^{b}±0.30	0.5462 - 1.4565	0.71
21- Apricot	2.5144^{a}±0.25	0.9227 - 4.9147	1.4757^{b}±0.46	0.7948 - 1.8821	0.8195^{c}±0.38	0.4952 - 1.3864	0.73

Results from Table II illustrate to lead content in leafy, fruity vegetables and fruit samples which were determined among five periods of samples collection during the period of 1/5/2010 to 1/11/2012 (about 6 months in each period). Data revealed that the highest mean levels of lead in leafy vegetables were detected in industrial and traffic areas during the period of 1/5/2010 to 26/10/2010, which recorded 18.2428 and 4.1894 mg/kg, respectively. However, the highest lead levels in rural areas were observed in the period of 1/11/2011 to 30/4/2012 (Table II), which recorded mean value of 2.2149 mg/kg. Analysis of variance indicated that a highly significant difference ($p \leq 0.05$) was observed between lead contents in some samples of different areas during the different periods. On the other hand, fruity vegetables (Table III) contained the highest mean values of lead in the samples collected from industrial, traffic, and rural areas during the period of 1/11/2010 to 30/4/2011, which recorded mean values of 4.3450, 2.7731 and 1.3092 mg/kg, respectively. Regarding to fruit samples (Table IV), data indicated that the highest mean values of lead (3.3165 mg/kg) in industrial areas was found in collected samples during of the period of 1/5/2010 to 26/10/2010. While, the highest mean lead concentration of traffic and rural areas was detected in the samples collected during the period of 1/11/2010 to 30/4/2011 and 1/5/2012 to 1/11/2012, which recorded 2.3401 and 1.1627 mg/kg, respectively. These results were confirmed by statistical analysis, which highly significant differences ($p \leq 0.05$) were observed.

The previous periods of samples collection adjacent the samples collection of summer and winter. Comparing lead levels in the samples collection of the three areas among the two seasons (Tables V-VII), data proved that the highest mean values were detected in leafy vegetable samples of winter, while the highest mean levels in the collected samples of summer were detected in both fruity vegetables and fruit samples. Statistical analysis confirmed that highly significant difference ($p \leq 0.05$) was found between the lead levels in the collected samples of winter and in summer.

TABLE II
LEAD CONTENTS (MG/KG) IN LEAFY VEGETABLE SAMPLES FROM INDUSTRIAL, TRAFFIC, AND RURAL AREAS DURING THE PERIODS OF SAMPLE COLLECTION

Areas	Mean concentrations (mg/kg) ± SD					LSD at 5%
	1	2	3	4	5	
Industrial	18.2428^{a}±4.94	2.6776^{c}± 0.25	2.3710^{c}±0.13	5.3446^{b}±0.53	2.4651^{c}±0.5	1.00
Traffic	4.1894^{a}±3.11	2.5092^{b}±0.66	1.9963^{c}±1.34	4.1075^{a}±0.09	2.4500^{b}±0.66	0.49
Rural	0.4894^{c}±0.02	1.1822^{b}±0.26	0.4445^{c}±0.17	2.2149^{a}±0.11	1.1543^{b}±0.14	0.22

-All values are means of samples number determinations in each period from each area ± standard deviation (SD).
-Means within columns with different letters are significantly different ($p \leq 0.05$)
1- 1/5/2010 to 26/10/2010 **2-** 1/11/2010 to 30/4/2011 **3-** 1/5/2011 to 20/10/2011
4- 1/11/2011 to 30/4/2012 **5-** 1/5/2012 to 1/11/2012

TABLE III
LEAD CONTENTS (MG/KG) IN FRUITY VEGETABLE SAMPLES FROM INDUSTRIAL, TRAFFIC, AND RURAL AREAS DURING THE PERIODS OF SAMPLE COLLECTION

Areas	Mean concentrations (mg/kg) ± SD					LSD at 5%
	1	2	3	4	5	
Industrial	2.5171^{b}±0.20	4.3450^{a}±00.20	2.9075^{b}±0.12	1.5839^{c}±0.05	1.1353^{c}±0.08	0.61
Traffic	1.6610^{c}±0.05	2.7731^{a}±0.09	2.1960^{b}±0.24	0.4625^{d}±0.08	1.3096^{c}±0.06	0.50
Rural	0.2237^{b}±0.02	1.3092^{a}±0.12	1.2340^{a}±0.08	0.3175^{b}±0.05	1.0593^{a}±0.32	0.21

-All values are means of samples number determinations in each period from each area ± standard deviation (SD).
-Means within columns with different letters are significantly different (p≤0.05).
1- 1/5/2010 to 26/10/2010 **2-** 1/11/2010 to 30/4/2011 **3-** 1/5/2011 to 20/10/2011
4- 1/11/2011 to 30/4/2012 **5-** 1/5/2012 to 1/11/2012

TABLE IV
LEAD CONTENTS (MG/KG) IN FRUIT SAMPLES FROM INDUSTRIAL, TRAFFIC, AND RURAL AREAS DURING THE PERIODS OF SAMPLE COLLECTION

Areas	Mean concentrations (mg/kg) ± SD					LSD at 5%
	1	2	3	4	5	
Industrial	3.3165^{a}±0.58	3.0200^{a}± 0.14	2.6447^{b}±0.84	1.8730^{c}±0.14	1.5872^{c}±0.17	0.56
Traffic	1.0754^{c}±0.16	2.3401^{a}±0.06	1.8499^{b}±0.08	1.3444^{c}±0.08	1.8421^{b}±0.09	0.58
Rural	0.4814^{c}±0.08	1.1143^{a}±0.06	0.6856^{c}±0.14	0.9549^{b}±0.08	1.1627^{a}±0.28	0.28

- All values are means of samples number determinations in each period from each area ± standard deviation (SD).
- Means within columns with different letters are significantly different (p≤0.05).

1- 1/5/2010 to 26/10/2010 **2-** 1/11/2010 to 30/4/2011 **3-** 1/5/2011 to 20/10/2011
4- 1/11/2011 to 30/4/2012 **5-** 1/5/2012 to 1/11/2012

TABLE V
LEAD CONTENTS (MG/KG) IN LEAFY VEGETABLE SAMPLES FROM INDUSTRIAL, TRAFFIC, AND RURAL AREAS DURING SUMMER AND WINTER SEASONS

Areas	Mean concentrations (mg/kg) ±SD		LSD at 5%
	Summer	Winter	
Industrial	3.4583^{b}±0.81	4.9916^{a}±0.34	1.21
Traffic	2.2105^{b}±0.51	3.8777^{a}±0.56	0.49
Rural	1.1260^{b}±0.06	2.0259^{a}±0.05	0.28

- All values are means of samples number determinations in each season from each area ± standard deviation (SD).
- Means within columns with different letters are significantly different (p≤0.05).

TABLE VI
LEAD CONTENTS (MG/KG) IN FRUITY VEGETABLE SAMPLES FROM INDUSTRIAL, TRAFFIC, AND RURAL AREAS DURING SUMMER AND WINTER SEASONS

Areas	Mean concentrations (mg/kg) ±SD		LSD at 5%
	Summer	Winter	
Industrial	1.1364^{b}±0.11	2.3719^{a}±0.16	0.22
Traffic	1.5270^{a}±0.07	1.1267^{b}±0.09	0.34
Rural	0.9197^{a}±0.07	0.6008^{b}±0.07	0.19

- All values are means of samples number determinations in each season from each area ± standard deviation (SD).
- Means within columns with different letters are significantly different (p≤0.05).

TABLE VII
LEAD CONTENTS (MG/KG) IN FRUIT SAMPLES FROM INDUSTRIAL, TRAFFIC, AND RURAL AREAS DURING SUMMER AND WINTER SEASONS

Areas	Mean concentrations (mg/kg) ±SD		LSD at 5%
	Summer	Winter	
Industrial	2.2914^{a}±0.42	2.2553^{a}±0.53	0.22
Traffic	1.6597^{a}±0.67	1.7102^{a}±0.09	0.21
Rural	0.8731^{a}±0.03	1.0080^{a}±0.07	0.20

- All values are means of samples number determinations in each season from each area ± standard deviation (SD).
- Means within columns with different letters are significantly different (p≤0.05).

IV. DISCUSSION

Vegetables and fruits are important parts in human's diet. In addition to a potential source of important nutrients, vegetables and fruits constitute important functional food components by contributing protein, vitamins, iron, and calcium which have marked health effects. Human beings are encouraged to consume more vegetables and fruits. However, these plants contain both essential and toxic metals such as lead over a wide range of concentrations. Different investigations confirmed that plants take up metals by absorbing them from contaminated soil. In addition, the most important source of contamination is atmospheric pollution [31], [32] from industrial or motor vehicle emission, which represent from 73 to 95% of the total lead in plants [33]. On the other hand, wastewater irrigation is known to contribute significantly to the heavy metal contents of soils which transfer to the plant [34], [9].

The present investigation provides additional data onto the lead contaminated foods in Egypt. This study also, can help in risk assessment of consumer exposure to expected lead levels. The mean concentrations of lead in different vegetables and fruit samples from the three areas (industrial, traffic and rural) were studied. Lead levels in these samples are quite variable. The vegetables and fruits from industrial areas exhibited higher levels of lead than the traffic areas. In contrast, vegetables and fruits from rural areas contained the lowest levels. Lead content in most vegetables and fruit samples (molokhia, parsley, coriander, leek, garden rocket, green peas, green pepper, tomatoes, potato tubers, guava and apricot) from industrial areas were significantly (p≤0.05) higher as compared to those in the traffic and rural areas. However, there were no significant (p≥0.05) variations in the levels of lead in vegetables and fruits from industrial areas (dill, leek, Egyptian mallow, eggplant, cucumber, grape, and peaches) as compared to those in traffic areas samples and no significant differences (p≥0.05) was observed between the samples

(radish and potato tubers) from traffic areas as compared to those in rural areas. In the present study, leafy vegetables appear to contain high levels of lead. One possible explanation of this situation is that the lead uptake can be promoted by the pH of soil and the levels of organic manner [35]. Kloke et al. [36] reported that heavy metals accumulate in different ratios in vegetables and this could be attributed to various factors such as; surface
area of root exudates, the rate of evaporation- aspiration and metal concentration in the soil. Similar results were reported to several authors. This trend is similar to those reported in a previous study in Egypt [37], [15], [38] and in other countries: Greece [39], Tanzania [40], Ethiopia [41]. On the other hand, the concentrations of lead in potatoes were lower than those detected in Pakistan [42].

In the present study, data proved that lead levels were variable during the different periods of samples collection and the two seasons (summer and winter). These results confirmed that lead concentrations not stable in the atmosphere. The environmental contamination by lead in different areas leads to the contamination of foods at variable levels due to the seasonal variation. The seasonal mean variation on lead concentrations of the atmosphere of city center of Cairo and Dokki areas during the period from winter (1998) up to winter (1999) were studied by [43]. It reveals that the maximum mean concentration of lead was 2200 and 1700 ng/m^3 in winter, while the minimum was 1300 and 1100 ng/m^3 during the summer season at the city centre and Dokki sites, respectively. These levels decreased to 455 ng/m^3 in summer and 664 ng/m^3 in winter during the period of 2001 and 2002 in the atmosphere of Faysal area. The seasonal variations on lead concentrations may occur to the effect of seasonal meteorological variations. The temperature inversion layers within the atmosphere are more persistent in winter than in summer for producing the seasonal variations on lead concentration [4].

Lead levels detected in the present study are comparable with those of previous Egyptian investigations. In our study, vegetables and fruit samples exhibited higher levels of lead than other detected by [44] who reported that potato tubers and cucumber contained (0.111-0.429) and (0.124-0.445) mg/kg, respectively. Radwan and Salama, [45] showed that spinach, lettuce, green pepper, tomatoes, potato tubers, eggplant, cucumber and peaches contained 0.34, 0.58, 0.47, 0.26, 0.01, 0.21, 0.19 and 0.38 mg/kg, respectively. While [37] indicated that spinach and lettuce contained 0.56 and 0.07 mg/kg, respectively. On the other hand, [15] proved that molokhia, parsley, coriander, dill, leek, spinach, Egyptian mallow, radish, celery, lettuce, green pepper, tomatoes, potato tubers, eggplant, cucumber, grape and peaches contained 0.429, 0.182, 0.181, 0.206, 0.206, 0.296, 0.246, 0.279, 0.200, 0.418, 0.175, 0.196, 0.412, 0.138, 0.362, 0.092 and 0.438 mg/kg, respectively. In other investigation into [46], they reported that parsley, dill and celery contained 2.59, 1.49 and 0.113 mg/kg/dw, respectively. Regarding to study of [38], they revealed that molokhia, parsley, coriander, dill, leek, garden rocket, spinach, Egyptian mallow, radish, celery, lettuce, tomatoes, potato tubers and peaches contained 0.65, 0.18, 0.15, 0.18, 0.31, 0.18, 0.30, 0.37, 0.34, 0.26, 0.11, 0.15, 0.14 and 0.56 mg/kg, in the same order. However, EHP, [47] reported that parsley, dill, lettuce, green pepper, tomatoes, potato tubers, eggplant, cucumber, and peaches contained 0.7472, 0.4754, (0.230-10.10), (0.018-0.044), (0.011-0.021), (0.017-0.570), (0.012-0.025), (0.018-2.800) and (0.016-0.031) mg/kg, in this order.

According to the recommended tolerance limits of [48], it is clear that the levels of lead in different samples were higher than the Maximum Residue Limits (MRLs, 0.2 mg/kg for vegetables and 0.3 mg/kg for fruits).

In the present investigation, vegetables and fruits were collected from Shoubra El-Kheima and Helwan (industrial areas). Shoubra-El-Kheima as an industrial complex is at the northern boundary of Cairo. It has an area about 30 Km^2 and houses over 800 plants of various sizes. The textile manufacturing is the predominant activity, followed by engineering construction, chemical fertilizers, petroleum, and electrical industries. The area, also, accommodates much big thermal power generating plants. Emission from these industries and activities directly affect the air quality in the Greater Cairo area [4]. The authors reported that the annual mean concentration of lead (721 ng/m^3) in the Egyptian atmospheric industrial areas northern Cairo (Shoubra El-Kheima) was higher than that detected by [6] in the Egyptian atmospheric industrial areas in south Cairo (El-Tibeen), which was 623.4ng/m^3. In addition, the heavy industrial area of Helwan is about 20Km south west of Giza. The most important industries in this area include iron and steel manufacture, cook, cement, chemical, fertilizer, brick and car factories, textile, and thermal power generating plants [4].

The amounts of lead in the leaves of different vegetable samples of industrial areas were studied. Farooq et al. [35] collected different types of vegetable samples grown in an effluent irrigated fields in the vicinity of an industrial area of Faisalabad, Pakistan. They found that lead levels were 2.251, 2.652, 2.411, 2.035, 1.921 and 1.331 μg/g in spinach, coriander, lettuce, radish, cabbage and cauliflower, respectively. Dermirezen and Ahmet [10] analyzed different samples of vegetables and recorded high concentration (3.0-10.7 μg/g) of lead which poses health risks to human life. In another study, [12] reported that lead (17.54-25.00 μg/g) in vegetables grown in waste water industrial areas was above the safe limit (2.5 μg/g). Muchuweti et al. [49] reported the level of lead (6.77 μg/g) in vegetables irrigated with mixtures of waste water and sewage from Zimbabwe to be higher than WHO safe limit (2.0 μg/g). Fytianos et al. [50] recorded a high concentration of lead in spinach grown in industrial and rural areas of Greece. Al Jassir et al. [51] studied 6 washed and unwashed green leafy vegetables from Saudi Arabia and noted the highest concentrations of lead in the coriander (0.171 μg/g).

Although atmospheric lead originates from a number of industrial sources, leaded gasoline appears to be a principal source of general environmental leaded pollution [43]. Tetraethyl lead was introduced to an antiknock agent in gasoline in the 1920s [52] and since then it has played an increasingly important role as a pollutant of the general atmosphere. In the present investigation samples were collected from the residential area of Faysal which characterized as heavy traffic, many new buildings under construction and unpaired roads. It also located south west the city center of Cairo city, so the main source of lead was the heavy traffic emission and that transported by winds from the city centre. Atmospheric lead concentration differs from one country to another. It depends on motor vehicle density and efficiency of efforts to reduce the lead content of gasoline [53], [54]. It has been estimated that vehicles contribute 80-96% of all lead emissions of the atmosphere [55]. It has been shown that 70-80% of the lead intake of the motor is expelled from the atmosphere whereas the remaining 20-30% accumulates in the exhaust system and in the lubricating oil [56]. Recently, the government of Egypt introduced to measure to reduce the lead concentration of the environment. These include the use of natural gas as fuel to houses and in some vehicles, as well as, the establishment of a long net underground metro in Cairo city. The beginning of the year 1991, the Egyptian authorities reduced significantly the lead content of gasoline sold in Cairo, where the lead problem had been the most serious. It was planned that in a five-year period by 1996, the gasoline sold must be completely unleaded [43].

The high levels of lead were also determined in vegetables and fruits from traffic areas (Faysal). These results might be closely related to pollution from the highways traffic. Accumulation of lead in different parts of vegetables growing around 6 Egyptian roads was early studied by [57]. They found that leafy vegetables (lettuce and cabbages) accumulated to lead up to 78.4 µg/g in their edible portion, while the lowest lead accumulations were given in carrots and radish (10.2 µg/g), concentrations in fruits of pepper and tomatoes were ranged between (0.70 to 18.60 µg/g). They added that the extent of contamination with lead depends on traffic densities and distance from the road.

The relatively high concentrations of lead found in vegetables and fruits are certainly due to irrigation with contaminated water as well as the addition of some fertilizers and insecticides. In addition, it was reported that the contamination of vegetables and fruits with lead depends on several factors, e.g. traffic densities and distance from the road [58]. They suggested that lead accumulated in plants through both foliage and root systems, but lead absorption through foliage is more pronounced at locations close to the emission source of lead vapor and fine particles. They also recorded that, concentrations of lead in fruits were dependent on its levels in the leaves rather than in the roots or soils and the emission of lead from the traffic and street dust [4].

IV. Conclusion and Recommendation

From the available data, it could be concluded that lead concentration in vegetable and fruit samples are relatively high. Levels of lead in different samples of industrial areas are much higher as compared to those from rural areas. Residents near heavy traffic areas are at high-risk for lead pollution. The elevated levels of lead in the people bodies may result in various health and developmental problems. It can be recommended that monitoring and evaluation of lead levels in foods at regular intervals and maintaining data base is very important. Also, put to plan by specified organizations of preventing exposure to controlling or eliminating lead sources.

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