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EVALUATION OF HEAVY METAL CONTENTS AND ORGANOCHLORINE PESTICIDES (OCPs) RESIDUES IN EGYPTIAN ORGANICALLY-FARMED VEGETABLES

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ABSTRACT

Heavy metal contents and organochlorine pesticide (OCPs) residues in three kinds of organic-vegetables namely; green onion, root beet and potatoes and their corresponding soils from Egypt were investigated. Heavy metal contents were measured by using atomic absorption spectrophotometer and gas chromatography for determination pesticide residues. The concentrations of heavy metals iron (Fe), zinc (Zn), copper (Cu) and lead (Pb) in organically-farmed soils ranged from 581.67 mg/kg to 741.67 mg/kg, 1.67 mg/kg to 1.97 mg/kg, 0.46 mg/kg to 0.70 mg/kg and 1.06 mg/kg to 1.23 mg/kg, respectively. However, their concentrations in organic vegetables under investigation ranged from 25.20 mg/kg to 89.83 mg/kg (Fe), 3.81 mg/kg to 5.94 mg/kg (Zn), 1.60 mg/kg to 2.91 mg/kg (Cu) and 1.60 mg/kg to 3.80 mg/kg (Pb). There were significant positive correlations between Fe ($P<0.05$) in organic vegetables and their corresponding soils; but no significant correlation was found between concentrations of Zn, Cu and Pb in soils and vegetables. Comparing the obtained results given in this investigation with the recommended tolerance limits of FAO/WHO (FAO/WHO,1989); the level of Pb in organic vegetables was higher than the maximum residue limits (MRLs) (0.2 mg/kg) in vegetables. The concentrations of OCPs residues were ranged from 9.94µg/kg to 10.82µg/kg in organically–farmed soils. Organic vegetables under investigation showed detectable residues of OCPs, ranged from 3.27µg/kg to 4.95µg/kg, even though at level significantely below the MRLs of FAO/WHO (FAO/WHO, 1993)]. The effect of washing, peeling and cooking on the levels of heavy metals was investigated. It was found that all methods have an efficient role in the elimination of toxic heavy metal, Pb. On the other hand the loss of the heavy metals Fe, Zn and Cu for human health were in the order washing< cooking<peeling. So, adequate washing, of vegetables used in raw form and cooking after careful washing for that which need cooking is important to eliminate toxic heavy metals, and are important for human health. On the other, hand peeling process was necessary to remove the greatest amounts of pesticides in the skin. Washing with water and acetic acid, as well as cooking also had an efficient role in eliminating contamination of pesticide residues.
Keywords: Organic farms • Heavy metals• OCPs •Vegetables.

INTRODUCTION

Consumption of vegetables is one of the most important pathways by which heavy metals and pesticides enter the food chains. Both the farmland and urban environment often suffer from the metal contamination due to irrigation with wastewater and traffic emission. Vegetables absorb heavy metals from soil as well as from surface deposits on parts of vegetables exposed to polluted air, in addition the use of polluted water from the irrigation of vegetables (McLachlan, 1996; Wang *et al.*,2004)] causing serious health hazards such as damage in central nervous system, permanent mental retardation in children, kidney disease and anemia. Toxic metals are generally interfering with cellular biochemistry, mainly by disruption of a variety of enzymes; metal can alter normal patterns of growth, reproductive function, immune function and general metabolism. Secondarily, toxic metals interfered with the normal metabolism and function of required metals (e.g., calcium and magnesium), but metals interactions are poorly understood in many animals. In extreme conditions, some metals are known to be carcinogenic, mutagenic or teratogenic (Friberg *et al.*, 1986). Persistent organic pollutants (POPs) are characterized by exceeding long half-life's in the environment and a potential for bioaccumulation through food chains. Included in this group are organochlorine pesticides (OCPs) (Wania, and Mackay, 1996& Gonzalez *et al.*, 2005). Pesticide have been routinely used in most countries of the world to control harmful pests, mainly in agriculture (68%) as well as (17%) in industrial activities (Cantoni and Comi, 1997). Therefore, high levels of these chemicals due to their extensive agricultural application and industrial emission in the world may cause contamination of foodstuffs. The stability of certain pesticides, particularly the chlorinated hydrocarbons, and the fact their residues can remain in the foods, increases the human health hazard. Persistent organchlorine pesticides play an important role in chronic poisoning (Sitarska *et al.*, 1991) cancer immune system disorders and reproductive abnormalities [PAN, (Pesticide Action Network) 2001].

Organic agriculture has developed rapidly during the last decade and, governments have encouraged the development of this tillage practice, mainly in developed countries. They are distinguished from all other forms of farming, namely convential by rejection of soluble minerals as fertilizer and synthetic pesticide in favor of natural one (Trewavas, 2004). However, like conventionally-farmed products, organic crops are grown in soils that may be contaminated with POPs at low concentration from past applications of agrochemicals or wastes or from atmospheric deposition of volatile and semi-volatile organic compounds (Zohair *et al.* 2005). Therefore this study aimed to find more information related to the levels of heavy metals and residues of persistent potentially toxic and bioaccumulative organic compounds (OCPs) in organic soils in El-Sadat City, Menufiya Government, Egypt and their uptake by organic-farmed vegetables namely green onion, root beet and potatoes to make more informed choices regarding the value of organic products relative to convenantional products. Beside the role of washing and cooking on reducing of pesticide residues and heavy metals in previous samples was also studied.

MATERIAL AND METHODS

1. Material

1.1. Soil and crop sampling preparation

A total of 45 samples, which represented three different types of vegetables (15 samples of each green onion, root beet and potatoes) were collected from organic farm in El-Sadat City, Menufiya government, Egypt, and corresponding soils in which they were grown, were randomly collected from the field during harvest. Approximately 2 Kg soil was taken from the cultivated horizon and thoroughly homogenized by grinding to pass a 2mm sieve before sub-samples, which were stored in amber glass bottles in a freezer until analysis for heavy metals and pesticide residues. Three samples of each vegetable were processed. Potatoes and root beet samples were peeled with a vegetable peeler to a depth of 2mm. Green onions were fractionated into leave and root. The peel, core, leave and root were separately homogenized using a food processor and packed in an amber glass bottles and stored in a freezer until analysis to determine the distribution of metals and pesticide residues during the process.

1.2.Refernce standards and chemicals

Standard solution of heavy metals lead (Pb), iron (Fe), zinc (Zn) and copper (Cu) were provided by Merck Company (Merck, Darmstadt, Germany), at concentration of 100mg/l (1000ppm).Different working concentration were prepared to establish the standard curve, Organochlorine pesticide (OCPs) standards of 1-(*o*-chlorophenyl)-1-(*p*'-chlorophenyl)-2,2,2,-trichloroethane (*o,p*'-DDT), 1,1,1-trichloro-2,2-bis-chlorophenyl ethane (*p,p*'-DDT), 1-(*o*-chlorophenyl)-1-(*p*-chlorophenyl)-2,2-dichloroethane (*o,p*'-DDD), 1,1-dichloro-2,2-bis(p-chlorophenyl) ethane *p*'-DDD, 2,2-dichloroethlene (*o,p*'-DDE), 1,1-dichloro-2,2-bis(p-chlorophenyl) ethylene (*p,p*'-DDE),lindane (1-HCH) , aldrine, dieldrine, heptachlor, heptachlor-epoxide, HCB, endrine and endosulfan were purchased from Chem. Service Inc. (West Chester, PA, USA). All chemicals, used for extraction were obtained from E. Merck Company (Germany).

All test compounds were > 99% purity. All solvents were checked for the absence of components that could produce interfering peaks in the G.C analysis. Sodium sulfate (Na_2So_4) anhydraus was purified by heating in a furnace at 600 ^{O} C for 5h.

1.3Washing

Green onion, root beet and potatoes samples were washed using tap water and acetic acid solution 2% concentration.

1.4Peeling

Root beet and potatoes was peeled using vegetable peeler to a depth of 2mm.

1.5Blanching

Blanching was done by placing potato tubers in a covered cooker that contained water, and then heated to boiling at 100 ^{O}C on a stove top and in microwave oven using energy levels of 70% (700W) for 6min.

1.6Grilling

Gr:lling was carried out in home gas oven and in microwave oven using energy levels of 70% for 5 min.

2Analytical methods

2.1Heavy metals

They were extracted from organic vegetable and soil samples according to the method of AOAC [AOAC, 1990]. The concentration of the studied metals was determined using Perkin-Elmer (2380) atomic absorption spectrophotometer with flame atomization (air-acetylene), equipped with a 10cm burner and a deuterium lamp for background correction. Maximum absorbance was obtained by adjusting the cathode lamps at specific slit width and definite wavelengths as recommended by the method as follows, 0.7,283.3 mm(Pb); 0.2,248.3mm(Fe), 0.7, 213.9; and 0.7,324.8mm (Cu), respectively.

2.2Pesticide residues

They were extracted according to the method of the AOAC (AOAC, 1995). Aliquots of 1-2 µl of extract were injected into a Hewlett-Packard gas chromatography Model 5890 equipped with an ^{63}Ni electron capture detector (ECD) and flame ionization detector (FID) fitted with a HP-101 capillary column (cross-linked methyl silicon gum), 30m x 0.25mm x 0.25 um film thickness. The oven temperature was programmed from 160 to 220 ^{O}C at the rate of 5 ^{O}C/min, held for 20 min, injection and detector temperatures were 220 ^{O} C and 300 ^{O} C, respectively.

2.3 Statistical analysis

The obtained data was statistically analyzed according to Snedecor and Cochran. (Sndecor and cochran, 1980).

RESULTS AND DISCUSSION

Results in Table 1 show heavy metal concentrations of the soils in which organic vegetables, green onion, root beet and potatoes were grown.

The relative distribution of metals exhibited the following order iron> zinc>lead>copper with mean concentration ranged from 581.67mg/kg to 741.67mg/kg, 1.67mg/kg to 1.97mg/kg, 1.06mg/kg to 1.23mg/kg and 0.46mg/kg to 0.70mg/kg, respectively. Low concentration of metals is exactly as would be expected due to the type of soil under investigation which was sandy; since sandy matrices have normally low heavy metals sorption capacities (Abollino *et al.*, 2002).

Heavy metal concentrations in the organic vegetable samples under investigation are shown in Table 2. The results revealed that the highest mean levels of Fe (89.83mg/kg) were detected in green onion followed by root beet (51.75mg/kg) and potatoes (25.2mg/kg). The concentration of Fe in organic green onion and potatoes under investigation was higher than those grown in conventional farms reported by Soliman *et al.*, 1997. They found that green onion and potatoes collected from the Great Cairo governorates contained 7.1mg/kg and 6.3 mg/kg iron, respectively. The results agree with those reported by Worthington[Worthington,2001], who found that more Fe, Mn, P and vitamin C in organic crops as compared to conventional crops.

The same trend was observed with Zn and Cu; as their levels in organic vegetable under investigation ranged from 4.94mg/kg to 5.94mg/kg and 1.6mg/kg to 2.9mg/kg, respectively as compared to 1.0mg/kg to 3.1mg/kg Zn and 0.8mg/kg to 2.3mg/kg Cu for conventional vegetables (Soliman *et al.*, 1997). In general heavy metal contents in different plants depend on climatic factors, plant species, air pollution, and other environmental factors. (Sovjanski *et al.*, 1989)

Some heavy metals pose greater health concern than others, due to toxicity and likelihood of exposure, e.g. lead. The other elements are often necessary as trace minerals, e.g. Zn and Cu which are considering as natural essential components of enzymes and coenzymes and are important for growth, phytosynthesis and respiration.

Table 1: Heavy metal concentrations and organochlorine pesticide (OCPs) residues in organically-farmed soils

Compounds	Mean of metals and OCPs residue concentrations ±SD		
	Root beet	Green onion	Potatoes
I- Heavy metals (mg/kg)			
Fe	696.33 ± 33.29	741.67±61.08	581.67 ±42.1
Zn	1.76 ± 0.19	1.97 ± 0.22	1.67±0.51
Cu	0.7 ± 0.31	0.55 ± 0.07	0.46±0.12
pb	1.06 ± 0.24	1.2 ± 0.18	1.23±0.26
II-OCPs (µg/kg)			
O,P'-DDT	0.61±0.21	1.19±0.15	0.92±0.32
P,P'-DDT	1.01±0.29	0.83±0.26	0.78±0.11
O,P'-DDD	ND	ND	ND
P,P'-DDD	ND	ND	ND
O,P'-DDE	1.53±0.5	1.85±0.71	1.34±0.46
P,P'-DDE	3.75±1.23	2.9±1.14	3.92±1.72
Total	6.9	6.77	6.18
Lindane	1.35±0.8	1.27±0.53	1.27±1.61
Aldrine	ND	ND	ND
Dialdrin	0.77±0.25	0.58±0.14	0.64±0.3
Heptachlor	0.26±0.11	0.31±0.12	0.28±0.09
Heptachlor-epoxide	ND	ND	ND
HCB	ND	ND	ND
Endrin	0.71±0.24	0.85±0.32	0.93±0.19
Endosulfan	0.83±0.31	1.03±0.63	0.64±0.27

ND: Non-detectable

Table 2: Heavy metal concentrations and organochlorine pesticide OCPs residues in organically-farmed vegetables

Compounds	Mean of metals and OCPs residue concentrations ± SD					
	Root beet		Green onion		Potatoes	
	Peel	core	leaves	root	Peel	core
I- Heavy metals (mg/kg)						
Fe	48.27±2.42	3.48±1.01	51.1±4.5	38.73±14.46	22.4±3.5	2.8±0.25
Zn	3.69±0.41	2.24±0.11	2.28±0.6	2.66±0.74	2.01±0.37	1.8±0.3
Cu	1.15±0.1	0.45±0.01	2.41±0.83	0.5±0.17	1.45±0.15	0.57±0.12
pb	3.37±1.03	0.43±0.21	1.68±0.17	1.54±1.07	1.15±0.23	0.45±0.13
II-OCPs (µg/kg)						
O,P'-DDT	ND	ND	ND	ND	ND	ND
P,P'-DDT	0.34±0.12	ND	0.5±0.15	0.23±0.07	0.31±0.05	ND
O,P'-DDD	ND	ND	ND	ND	ND	ND
P,P'-DDD	ND	ND	ND	ND	ND	ND
O,P'-DDE	0.42±0.18	0.25±0.08	0.59±0.19	0.33±0.1	0.39±0.09	0.30±0.09
P,P'-DDE	0.64±0.26	0.37±0.11	0.76±0.32	0.41±0.16	0.55±0.21	0.23±0.06
Total	1.4 ±0.27	0.62±0.16	1.85±0.35	0.97±0.19	1.25±0.24	0.53±0.14
Lindane	0.39±0.06	0.22±0.1	0.5±0.15	0.34±0.07	0.32±0.1	0.28±0.06
Aldrine	ND	ND	ND	ND	ND	ND
Dieldrine	0.35±0.08	ND	0.43±0.14	0.27±0.05	0.30±0.11	ND
Heptachlor	ND	ND	0.36±0.16	0.23±0.04	0.24±0.06	ND
Heptachlor-epoxide	0.24±0.1	ND	ND	ND	0.35±0.12	ND
HCB	ND	ND	ND	ND	ND	ND
Endrin	ND		ND	ND	ND	ND
Endosulfan	0.27±0.12	ND	0.41±0.22	0.25±0.06	0.23±0.07	ND

ND: Non-detectable

(Sovljanski *et al.*, 1990; Abou-Arab *et al.*, 1999) It was obvious from the results in Table 2 that root beet, green onion and potatoes showed high levels of lead which recorded (3.8mg/kg, 3.22mg/kg and 1.6mg/kg), respectively.Comparing the obtained results given in this investigation with the recommended tolerance limits of FAO/WHO (FAO/WHO, 1989),. it is clear that the level of Pb in organic vegetable samples were markedly higher than the MRLs (0.2ppm for vegetables). It was reported that the contamination of plants with lead depends on several factors e.g. traffic densities and the distance from the road (Bosque *et al.*, 1990), industial emissions and irrigation with contaminated water (Lund, 1990). It is also notable from the results in tables 1&2 that no correlation was observed between Pb, Zn and Cu contents in the soils and its uptake by vegetables. The same observation was found by Yoo-Sung& Song-Kung-Sik, (Yoo-Sung and Song-Kung-Sik, 1991). However there were significant positive correlations between Fe in organic vegetables and their corresponding soils ($P<0.05$).

Although organic-farming avoids the use of pesticides, residues may be remain from pre-organic farming applications or as a result of atmospheric deposition. The results in Table 1 show that DDT and its derivatives (6.18μg/kg to 6.90μg/kg) and lindane (1.27μg/kg to 1.35μg/kg) were the most frequently detected OCPs residues in the investigated soils. The occurrence of OCP residues in the organic farms confirms the importance of the pesticides application methods in the surrounded area , volatilization and wind dispersion, leaching and wash out of OCPs transport from conventional farms to organic farms [Gonzalez *et al.*,2005]. The results in Table 2 revealed that organic vegetables under investigation showed detectable residues of OCPs even though at level below the maximum residue limits (MRLs) of FAO/WHO(FAO/WHO, 1993). Total DDT levels ranged from 1.78μg/kg to 2.82μg/kg and lindane from 0.60μg/kg to 0.84μg/kg. The occurrence of OCPs in organic-farmed vegetables have been reported by Gonzalez *et al.*,2005 and Gonzalez *et al.*,2003; Zohair *et al.*, 2005. Food containing residues at or below the respective MRLs are considered to be toxicologically acceptable for long-term intake (White *et al.*, 2002). On this basis, the concentrations of OCPs residues in the organic vegetables analysed here should not give cause for concern, however it is possible that even such low levels of the contaminant may merit more detailed scrutiny in the near future. Pesticides Safety Directorate, (Pesticide Safety Directorate, 2001) and Codex Committee on Pesticide residue, (Codex Committee on pesticide Residue, 2001) have stated that the need for an Acute Reference dose (ARfD) will considered for all pesticides in the future, and the estimated short-term intake of pesticide residues will be compared with the ARfDs in order to interpret the possible risks (Renwick *et al.*, 2003).

The effect of washing, peeling and cooking on the level of heavy metals are illustrated in Table 3. It was obvious that the concentrations of heavy metal decreased after washing, peeling and cooking. The data showed that the percentages reduction of Pb, Zn, Cu and Fe by washing root beet, green onion and potatoes with tap water ranged from (76.24%-80.39%), (2.43%-6.23%), (15.64%-18.54%) and (11.28%-12.89%), respectively. The results also indicated the efficient role of washing by acetic acid solution 2%. It completely eliminated Pb contamination. These results agreed with those obtained by Igwegbe *et al.* 1992 and Soliman *et al.*, 1997. They reported that partial and complete removals of heavy metal were affected by washing process. All heavy metal under investigation significantly reduced by peeling, so peeling may remove nutrients if it is not done carefully. The removal percentage ranged from 73.27%-79.09% (Pb), 56.97%-63.05% (Zn), 72.19-74.73% (Cu) and 81.79%-84.39% (Fe) for potatoes and root beet, respectively. Some of the vegetables are used in raw form, but most of them require cooking for the improvement of digestability and platability. Regarding to the blanching and grilling (after careful washing with water) of intact potatoes on heavy metal concentrations, data in Table 3 indicate that the removal percentage of Zn, Cu and Fe were relatively low, ranging from (4.57%-14.92%), (3.25%-17.07%) and (10.35%-25.21%), respectively depending on the condition and cooking method. The loss of metals were in the order, grilling in microwave<grilling in gas < boiling in microwave<boiling on stove top. However lead was eliminated completely after cooking. Fe, Zn and Cu are important metals for human health, however other metal such as Pb has no biochemical or physiological importance so they are considered as very toxic pollutants (Sovljanski *et al.*, 1990), concerning this fact it is important to choice the method which could reduce the toxic heavy metal and not affect the useful one. It could be indicated that adequate washing process for vegetable used in raw form and cooking after carefully washing without skin removal for vegetable which need cooking, is the suitable way on the elimination of toxic heavy metals such as Pb and reduced loss of benefit heavy metals such as Zn, Cu and Fe.

Data in Table 4 clearly indicate that OCPs are abundant in the peels of both root beet and potatoes; loss of OCP residues (i.e., DDT and its derivatives, lindane, dieldrin and heptachlor) after peeling ranged from about 70.5% to 80%. They accord with those obtained by (Chirila and Florall, 1985; Abou-Arab *et al.*, 1999; Zohair *et al.*, 2005), who reprted that pesticide residues were removed after peeling. The results also showed that washing process and cooking eliminated about (13.3% to 41.67%) and (38.3% to 54.2%) OCP residues, respectively; depending on the type of pesticide, washing solution and cooking methods. These results are agree with those obtained by Abou-Arab, *et al.*,1998; Soliman, 1999; Zohair, 2001.

It could be concluded that more efforts are need to ensure that the general public are better informed about the risks from contaminants in foodstuffs and in particular, how they can reduce their personal exposure by simple procedures. This is particularly true with respect to environmental contaminants in organically-farmed vegetables, where much of the public may be misinformed with regards to the relative safety of such products as compared to their conventionally-farmed counterparts. However, it should be stressed that the levels of contaminants in vegetables can be reduced by carefully washing and appropriate preparation and cooking.

Table 3: Effect of washing, peeling and cooking on heavy metal concentrations (mg/kg) in organically-farmed vegetables

Treatments	Heavy metal concentrations (mg/kg)± SD							
	pb		Zn		Cu		Fe	
	Mean	Reduction%	Mean	Reduction%	Mean	Reduction%	Mean	Reduction%
Green onion								
Before washing	2.52±0.67		4.71±1.1		2.37±0.72		68.5±10.21	
washing with tap water	0.55±0.18	78.17	4.5±1.12	4.46	2.05±0.55	15.64	59.7±9.13	12.89
Acetic acid 2%	ND	100	4.11±0.96	12.74	1.96±0.29	2[illegible].21	58.65±5.62	14.38
Root beet								
Before washing	3.11±0.92		5.36±1.43		1.90±0.32		43.62±6.44	
washing with tap water	0.61±0.15	80.39	5.23±1.28	2.43	1.56±0.16	17.89	38.7±3.95	11.28
Acetic acid 2%	ND	100	5.01±1.31	6.53	1.34±0.22	24.74	35.66±5.19	18.25
Peeling	0.65±0.17	79.09	1.98±0.36	63.05	0.48±0.07	74.73	6.81±1.85	84.39
Potatoes								
Before washing	1.01±0.35		3.37±0.84		1.51±0.44		54.54±11.77	
washing with tap water	0.24±0.05	76.24	3.16±0.76	6.23	1.23±0.61	18.54	40.11±8.16	11.92
Acetic acid 2%	ND	100	2.95±0.52	12.46	1.1±0.38	27.15	38.52±6.52	15.42
Peeling	0.27±0.03	73.27	1.45±0.08	56.97	0.42±0.05	72.19	8.29±1.83	81.79
Blanching	ND	100	2.51±0.88	14.92	1.02±0.09	17.07	30.00±5.02	25.21
Blanching at microwave	ND	100	2.8±0.67	11.39	1.1±0.14	10.57	32.12±4.98	19.92
Grilling	ND	100	2.93±0.59	7.28	1.16±0.32	5.79	34.14±5.23	14.88
Grilling at microwave	ND	100	3.01±0.55	4.57	1.19±0.6	3.25	35.96±6.11	10.35

Values given are mean of three replicates
ND: Non-detectable

Table 4: Effect of washing , peeling and cooking on organochlorine psticide (OCP) residues (µg/kg) in organically-farmed vegetables

Treatments	OCPs concentrations µg/kg ± SD							
	Total DDT		Lindane		Dieldrine		Total Heptachlor	
	Mean	Reduction%	Mean	Reductio%	Mean	Reduction%	Mean	Reduction%
Green onion								
Before washing	2.82±0.28		0.84±0.11		0.7±0.15		0.59±0.19	
washing with tap water	2.32±0.96	17.73	0.7±0.03	16.67	0.52±0.18	25.71	0.47±0.1	20.34
Acetic acid 2%	2.13±0.97	24.47	0.58±0.19	30.95	0.46±0.13	34.29	0.36±0.09	38.98
Root beet								
Before washing	2.02±0.23		0.61±0.12		0.35±0.08		0.24±0.12	
washing with tap water	1.65±0.81	18.32	0.49±0.13	19.67	0.27±0.03	22.86	0.19±0.03	20.83
Acetic acid 2%	1.49±0.5	26.24	0.39±0.09	36.07	0.24±0.08	31.43	0.14±0.03	41.67
Peeling	0.55±0.38	72.77	0.18±0.03	70.49	0.09±0.02	74.29	0.05±0.01	79.17
Potatoes								
Before washing	1.78±0.20		0.6±0.03		0.3±0.11		0.59±0.18	
washing with tap water	1.53±0.78	14.04	0.52±0.06	13.33	0.22±0.02	26.67	0.48±0.12	18.64
Acetic acid 2%	1.22±0.66	31.46	0.40±0.03	33.33	0.19±0.06	36.67	0.37±0.07	37.29
Peeling	0.38±0.05	78.65	0.15±0.02	75	0.06±0.01	80	0.16±0.04	72.88
Blanching	1.06±0.21	40.45	0.37±0.04	38.33	0.15±0.03	50	0.33±0.05	44.07
Blanching at microwave	1.01±0.35	43.26	0.35±0.05	41.67	0.18±0.01	40	0.31±0.07	47.46
Grilling	0.97±0.18	45.51	0.32±0.07	46.67	0.16±0.02	46.67	0.29±0.05	50.85
Grilling at microwave	0.93±0.04	47.75	0.33±0.05	45	0.17±0.01	43.33	0.27±0.06	54.24

Values given are mean of three replicates **ND : Non-detectable**

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تقييم محتوي خضراوات المزارع العضوية في مصر من المعادن الثقيلة ومتبقيات المبيدات الكلورونية

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تمت دراسة ثلاثة أنواع من خضراوات المزارع العضوية والتربة التي زرع فيها كل نوع من هذه الخضراوات في مصر وكانت أنواع الخضراوات تحت الدراسة ممثلة في البصل الأخضر والبنجر والبطاطس من حيث محتواها من المعادن الثقيلة ومتبقيات المبيدات الكلورونية بها.واستخدم لتقدير تركيزات المعادن الثقيلة جهاز قياس الامتصاص الذري كما أستخدم جهاز كروماتوجرافيا الغاز لتقدير متبقيات المبيدات الكلورونية.وقد تراوحت تركيزات المعادن الثقيلة ممثلة في الحديد والزنك والنحاس والرصاص في تربة المزارع العضوية من ٥٨١,٧٦ –٧٤١,٦٧ ملجم / كجم و ١,٦٧ –١,٩٧ ملجم / كجم و ٠,٤٦– ٠,٧٠ ملجم / كجم و ١,٠٦–١,٢٣ ملجم / كجم علي التوالي. بينما تراوحت تركيزات تلك المعادن الثقيلة في الخضراوات المزروعة في هذه التربة ما بين ٢٥,٢٠–٨٩,٨٣ ملجم / كجم للحديد و ٣,٨١– ٥,٩٤ ملجم / كجم للزنك و ١,٦– ٢,٩١ ملجم / كجم للنحاس و ١,٦– ٣,٨١ ملجم / كجم للرصاص.وقد لوحظ وجود علاقة معنوية بين تركيز الحديد في الخضراوات العضوية وتركيزه في التربة التي زرع فيها بينما لم توجد هذه العلاقة بالنسبة لباقي المعادن الثقيلة تحت الدراسة. وبمقارنة التركيزات التي خرجت بها هذه الدراسة للمعادن الثقيلة في الخضراوات العضوية في مصر والحدود الموصي بالسماح بها من قبل منظمة الأغذية والزراعة ومنظمة الصحة العالمية عام ١٩٨٩ فإن مستوي تركيزات الرصاص المتواجد في خضراوات المزارع العضوية تحت الدراسة أعلي من الحد الأعلى الموصي بالسماح به وهو ٠,٢ ملجم / كجم .وقد تراوحت تركيزات متبقيات المبيدات الكلورونية في تربة المزارع العضوية بين ٩,٩٤–١٠,٨٢ ميكروجرام /كجم كما أظهرت الخضراوات العضوية المزروعة في ذات التربة تركيزات ملحوظة من متبقيات المبيدات الكلورونية والتي تراوحت ما بين ٣,٢٧– ٤,٩٥ ميكروجرام/ كجم وهذه التركيزات أقل من الحد الأقصى الموصي بالسماح به من قبل منظمتي الأغذية والزراعة والصحة العالمية لعام ١٩٩٣.

وبدراسة تأثير بعض المعاملات البسيطة علي خضراوات المزارع العضوية مثل الغسيل والتقشير والطهي علي خفض تركيزات المعادن الثقيلة ومتبقيات المبيدات الكلورونية فقد لوحظ أن كل المعاملات السابقة كانت فعالة في إزالة جزء من المعادن الثقيلة السامة مثل الرصاص. ومن جهة أخي فأن المعادن الثقيلة الأخرى مثل الحديد والزنك والنحاس والتي لها أهميتها لصحة الإنسان تفقد بنسبة كبيرة عند عملية التقشير وكانت نسبة الفقد في الغسيل < الطهي < التقشير لذلك يفضل الغسيل الجيد للخضراوات التي لا تحتاج للطهي والغسيل الجيد قبل الطهي أيضا لتلك التي تحتاج طهي حتى يمكن التخلص من المعادن السامة وفي نفس الوقت الاحتفاظ بالمعادن الهامة لصحة الإنسان .كذلك كان التقشير فعالا في إزالة المبيدات . ،أيضا كان الغسيل بالماء وحمض الخلليك بالإضافة إلي عملية الطهي أثر فعال في إزالة المبيدات.و أخيرا من كل ما تقدم ننصح ببذل الجهد للتأكد من نشر الوعي بين المستهلكين لتدريبهم علي التعامل مع المخاطر الناتجة عن تلوث الغذاء وبالأخص كيفية تفادي التعرض للملوثات الموجودة بالغذاء بطرق بسيطة وسهله.وحيث أنه من الحقائق التي ثبتت لدينا أن خضراوات المزارع العضوية والتي يعتبرها معظم المستهلكين آمنة بالمقارنة بالخضراوات المزروعة بالطريقة التقليدية وذلك نتيجة لنقص المعلومات عن مدي التلوث في خضراوات المزارع العضوية والتي من الممكن أن تتلوث عن طريق الهواء أو نتيجة مباشرة لزراعتها في أراضي ملوثة من الزراعات السابقة بمتبقيات المبيدات والتي تكون مقاومة للتحلل.لذا يجب التركيز علي أن مستويات التلوث في الخضراوات يمكن خفضها بالغسيل الجيد والأعداد المناسب والطهي وبالتالي الحصول علي غذاء آمن وصحي.