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EVALUATION OF SYNTHETIC PLANT GROWTH REGULATORS RESIDUES IN FRUITS AND VEGETABLES AND HEALTH RISK ASSESSMENT IN GIZA, EGYPT

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ABSTRACT

Plant growth regulators for vegetables and fruits have gained attention worldwide in recent years due to their widespread applications in agriculture and serious risks to the health and safety of consumers. The purpose of this paper was to assess the concentration of synthetic plant growth regulators residues (PGRs) in fruits and vegetables and to estimate the potential health risks associated with the PGRs regard to consumers to take preventive actions to minimize human health risks. Gas chromatography with mass spectrum detector was developed for the determination of four PGRs, including gibberellins, α- naphthalene acetic acid, 2, 4-dichlorophenoxyacetic acid and ethephon in locally produced fruits and vegetables were purchased from seven main markets in Giza Government, Egypt, during year 2014. Based on analytical studies PGRs residues were not observed in 34.4% samples of fruits and 39.3% samples of vegetables. The results obtained showed that PGRs residues were detected in 65.6% of fruit and 60.7% of vegetables. Fruits and vegetable contained samples with PGRs residues above safety limits were in the following order: Gib (71%) > 2,4-D (69%) > NAA (63%) > Eth (53%) for fruits while 2,4-D (74%) > NAA (66%) > Eth (45%) > Gib (42%) for vegetables. Data of acute hazard index revealed that Gib had the hazard effect in fig, plum, and tomato. In case NAA, hazard effect was observed in tomato only. Concerning the 2,4-D, hazard effect was showed in grape, apricot, and tomato. About the Eth, hazard effect was showed in all commodities except carrot, cabbage, and lettuce. The chronic hazard index of all the considered PGRs residues are high and rather > 1%.

Keywords: synthetic plant growth regulator, Gibberellins, α- naphthalene acetic acid, 2, 4- Dichlorophenoxyacetic acid and Ethephone.

INTRODUCTION

Plant growth regulators for vegetables and fruits have gained attention worldwide in recent years due to their widespread application in agriculture and serious risks to the health and safety of consumers. These food commodities are reported to be contaminated with toxic and health hazardous chemicals. A lot of chemical substances including plant growth promoters are used in agriculture (Mickel., 1978). Plant growth regulators are important production tools of horticultural and a gronomic crops, while their effects, particularly in an overdose situation, can be quite profound. Plant growth regulators are typically viewed as products that can be used to subtly manipulate a given plant growth process (e.g., flowering, vegetative shoot elongation, fruit abscission). Plant growth regulators are one of the most important factors for increasing higher yield in leafy vegetables. Application of growth regulators has a good management effect on growth and yield of field crops. Hormones regulate physiological process and synthetic growth regulators may enhance growth and development of field crops, thereby increased total dry mass of a field crop (Cho *et al*., 2008).

The value they create, particularly in horticulture crop area, can be quite significant and multidimensional (e.g. the use of naphthalene acetic acid on apples as a thinning agent early in the season, then as preharvest drops control. Current market trends, wherein demand for premium crop quality is growing at the same time input costs are being squeezed, will likely continue the drive to develop new plant growth regulators products that can help growers effectively achieve this market place balance (Sherly *et al.,* 2002). Growth regulators are defined as pesticides under The Pesticides Amendment Act, 1979. The use of handling facilities such as packing houses, hydrocoolers, controlled atmosphere and cold storage rooms for both organic and in-organic crops can result in the contamination of crops with post-harvest pesticides, especially fungicides and plant growth regulators (US, 1992). Auxin is the generic name for a class of plant hormones active in coordinating many growth processes in the life cycle of plants. Indole-3-acetic acid (IAA) is the most abundant and potent native auxin active in plants (Simon and Petrášek, 2011). 2-Naphthalene acetic acid (2-NAA) is used as a mimic for 1-naphthalene acetic acid synthetic auxin, which is commonly applied to stimulate the rooting potential of plant cuttings or to prevent fruit drop in orchards. The tolerance level of 2-NAA is set at 0.1 ppm according to the Pesticide Residue Limits in Foods (CODEX, 201٠). The widely used 2,4-dichlorophenoxyacetic acid (2,4-D) is a synthetic plant growth regulator stimulating responses similar to those of natural auxins. 2,4-Dichlorophenoxyacetic acid is an herbicide and secondarily a plant growth regulator (Tomlin., 2006). Crops treated with 2,4-D include field corn, soybeans, spring wheat, hazelnuts, sugarcane, and barley (RED., 2005). The tolerance level of 2,4-D is set at 0.1 ppm according to the Pesticide Residue Limits in Foods (CODEX, 201٠). Gibberellins (GAs) are a class of phytohormones that exert profound and diverse effects on plant growth and development (Ge, *et al*. 2007). Synthetic gibberellins are usually used to promote the growth of vegetables and fruits, and their combined action raises the productivity of them. But the residues of them have potential health risk to consumers. The tolerance level of GAs is set at 0.1 ppm according to the Pesticide Residue Limits in Foods (CODEX, 201٠). Ethephon is permitted to be applied to large berries, fruit vegetables, small berries, pome fruit and sugar cane groups of foods, and the tolerance level is set at 2 ppm according to the Pesticide Residue Limits in Foods (CODEX, 201٠). It is a plant growth regulator with systemic properties, penetrates into the plant tissues, and is translocated and progressively decomposed to ethylene (Royal Society of Chemistry. 1987), which is a kind of plant gas hormone which affects the growth processes of plants, including seed germination, fruit maturation, flower wilt, etc. Ethylene is widely used as a ripening accelerator in the post-harvest of fruits. The sources are pure ethylene gas, or gas generated from an ethylene generator, or ethephon. Ethephon was found to be the most effective nongaseous ethylene-releasing chemical (Hunter *et al*., 1978). Risk assessment for agricultural compound residues consists of assessing the toxicological risk of exposure to these residues and identifying the maximum residue limits, which the compounds should not exceed (US EPA, 2004). The purpose of this paper was to assess the concentration of synthetic plant growth regulator residues in fruits and vegetables and to estimate the potential health risks associated with the synthetic plant growth regulator residues with regard to consumers to take preventive actions to minimize human health risks.

MATERIALS AND METHODS

Sampling

A total of ٢٦٦ samples of fruits (pear, grapes, apricots, peach, guava, fig, plum, apple, date palm, and mango) and vegetables (carrot, rocket, cabbage, molikhia, lettuce, parsley, tomato, and cucumber) were purchased from several local markets in Giza Government, Egypt during year 2014. The markets where these foodstuffs were purchased included those of East, West, Middle, Giza, Eldoki, Embaba, Bolack El Dakror, El Omrania, Mariotia, and Kerdasa Districts (Figure 1). The markets were these foodstuffs were purchased include open markets, roadside grocery shops and peddlers. Sampling (١.0 kg, for each commodity from each district) was quite representative since the districts from where foodstuffs examined were scattered throughout the city. For the analysis, only the edible portions were included, whereas bruised or rotten parts were removed. All samples, vegetables and fruits were maintained at 2-5°C until analysis.

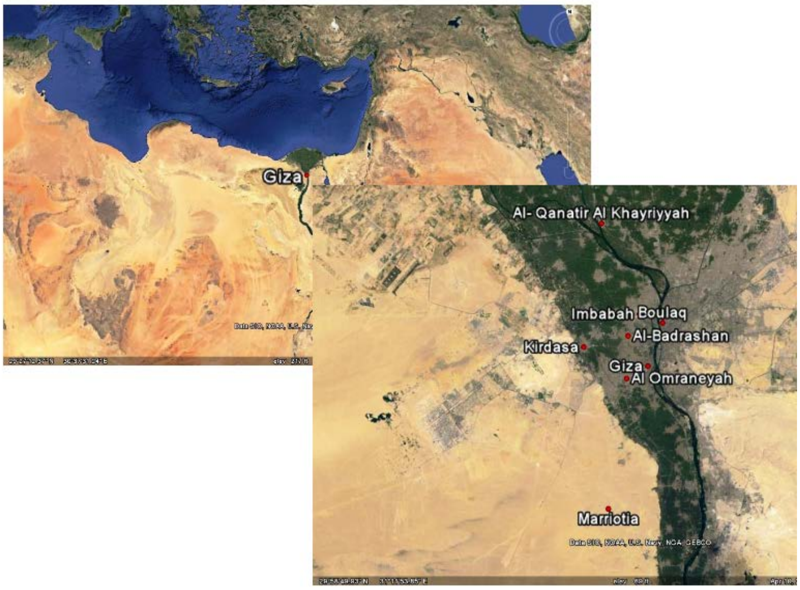


Fig. (1) Locations and description of local markets in Giza Government, Egypt

Sample preparation and treatment

Sample unit of fresh fruits and vegetable (١.0 kg) were thoroughly shredded and homogenized. Approximately 200.0 g of the sample was used for synthetic plant growth regulator analysis.

Extraction Procedures

Prior to extraction the fruit or vegetable tissue was pulverized in liquid N2. Aqueous methanol (80%) was added to thawed tissue. After homogenization, the extracts were filtered through a double layer of Whatman No.1 filter paper. Residual plant material was re-extracted twice, and the filtrates were pooled and reduced in volume by rotary evaporation under vacuum (Valerie and Jake., 1989).

Procedures and Capillary GC-MS

The procedure used was similar to that described by Sponsel, 1983. Aqueous extracts were adjusted to pH 8.0 by the addition of an equal volume of 0.2 M potassium phosphate (pH 8.0). Polyvinyl polypyrrol- idone was then added (1:2 w/v) and the extract stirred occasionally over a minimum period of 2h at 4°C before filtering through a double layer of Whatman No.1 filter paper. The filtrate was partitioned three times against equal volumes of petroleum ether and then three times against equal volumes of ethyl acetate. The pH 8.0 ethyl acetate phases were pooled and concentrated by rotary evaporation under vacuum. The concentrated material was placed in a small glass vial that had been silylated, dried under a stream of N_2, and re-dissolved in methanol for derivatization. The aqueous phase was readjusted to pH 3.0 using diluted phosphoric acid and extracted a further three times with ethyl acetate. The pH 3.0 ethyl acetate phases were pooled, concentrated, and re-dissolved in methanol as described for the pH 8.0 ethyl acetate extracts.

Derivatization Procedures and Capillary GC-MS

The various sample preparations were evaporated to near dryness in silylated glass vials in a stream of N_2 or under vacuum. Samples were re-dissolved in methanol, methylated (diazomethane), and tri-methylsilylated (hexamethyldisilazane and trimethylchlorosilane) for GC-MS analysis. The derivatized samples in CH_2Cl_2 were analysed by GC-MS. The conditions used for the analysis were: HP-5 m.s (cross-linked 5% phenyl methyl silicone) 30 m × 0.250 mm. carrier gas: helium, at flow rate 1.0 ml/min. detector; mass selective detector. The oven temperature was programmed as follows: 60°C (2 min) to 155°C at 10° min-' to 310°C at 30 min-' was used. The carrier gas pressure was 0.8 bar. The injection volume of the GC was 1.0 µL. External standard was used for quantitative evaluations (Valerie and Jake., 1989).

Risk Assessment

Consumption data play a major role in the dietary risk assessment of residues in fruits or vegetables. This risk was calculated through the comparison of found residues to the established Aacceptable Daily Intake (ADI) and Acute References Doses (ARD) values. The level of residue concentration in a product was determined as the arithmetic mean of all the results obtained. Results under LOD of analytical methods used for intake calculations were taken as LOD values. Values of ADI and ARfD are elaborated by Joint FAO/WHO Meeting on Pesticides Residues (WHO (World

Health Organization, 2003) and US EPA on Prevention, Pesticides and Toxic Substances (US EPA, 2007). For consumer residues intake estimation were applied new model from Pesticides Safety Directorate (PSD) of the Department for Environment (PSD, 2006). Calculations were performed for two sub- populations: children and adults. The estimated daily intake (*EDI*) of PGRs residues was calculated according to Łozowicka *et al*., 2013 as follows:

$$EDI = \sum \frac{Fi \times RLi}{mean\ body\ weight} \quad (1)$$

Where: *Fi* - food consumption data, *RLi* - residue level to the commodity.

The long-term risk assessment of the intakes compared to the PGRs toxicological data were performed by calculating the hazard quotient (*HQ*), by dividing the estimated daily intake with the relevant acceptable daily intake:

$$HQ = \frac{EDI}{ADI} \times 100\% \quad (2)$$

The *HQ* was calculated both for PGRs and commodities. The *HQ*s are summed up to give a Chronic Hazard Index (*C*HI):

$$CHI = \sum HQ \quad (3)$$

Estimate of Short-Term Intake (*ESTI*) was calculated according to the following formula:

$$ESTI = \sum \frac{F \times HR.P}{mean\ body\ weight} \quad (4)$$

where: *F* - full portion consumption data for the com-modity unit, *HR.P* - the highest residue level.

An estimate of intake of pesticide in the diet was to compare to the *ARfD*. The acute hazard index was calculated as follows:

$$aHI = \frac{ESTI}{ARfD} \quad (5)$$

RESULTS AND DISCUSSION

Plant growth regulators (PGRs) are the part of majority of contaminants of food supply and may be considered as the most important problem to our environment. The synthetic plant growth regulator not only affects the nutritive values of fruits and vegetables but also have deleterious effect on human beings using these food items. National and international regulations on food quality have lowered the maximum permissible levels of toxic synthetic plant growth regulator in human food; hence, an increasingly important aspect of food quality should be to control the concentrations of synthetic plant growth regulator in food. Residues of four synthetic plant growth regulators were detected in the most of analyzed samples, i.e Gibbrillic acid (Gib), α- naphthalene acetic acid (α-NAA), 2,4-Dichlorophenoxyacetic acid (2,4-D) and Ethephon (Eth). The discussion of the present study was focused on quantitative evaluations of the synthetic plant growth regulators residue results compared to the Maximum Residue Limits (MRLs) of the EU (2010) MRLs which apply on the Egyptian exports to the European countries.

PGRs Residues in fruit and vegetable

The mean concentrations and range of synthetic plant growth regulator residues of some fruits that collected from Egyptian local markets are presented in Tables 1. Based on our analytical studies, PGRs residues were not observed in 53 samples (34.4%) of fruits. Whereas PGRs residues were found in 101 samples (65.6%). PGRs residue levels were compared to EU-MRLs 2010. Number of non-contaminated and contaminated samples with synthetic plant growth regulator compared to EU-MRLs is shown in Figure 2. In most of analyzed samples 108 (71.0%) Gib residues were above safety limits (MRLs), 21.0% (33) were blew MRLs, while 8.0% (13) were at safety limits MRLs. In most of analyzed samples 98 (63.0%) NAA residues were above safety limits (MRLs), 31.0% (47) were blew MRLs, while 6.0% (9) were at safety limits MRLs. In most of analyzed samples 107 (69.0%) 2,4-D residues were above safety limits (MRLs), 28.0% (43) were blew MRLs, while 3.0% (4) were at safety limits MRLs. In most of analyzed samples 81 (53.0%) ethephon residues were above safety limits (MRLs), 39.0% (60) were blew MRLs, while 8.0% (13) were at safety limits MRLs. Fruits contained samples with PGRs residues above safety limits in the following order Gib (71%) > 2,4-D (69%) > NAA (63%) > Eth (53%).

Also, residues of four PGRs were determined in vegetable samples, the mean concentrations and range of PGRs residues of some fruits that collected from Egyptian local markets are presented in Tables 2. PGRs residues were not observed in 44 samples (39.3%) of vegetable. Whereas PGRs residues were found in 68 samples (60.7%). Number of non-contaminated and contaminated samples with PGRs compared to EU-MRLs is shown in Figure 3. In analyzed samples 47 (42.0%) Gib residues were above safety limits (MRLs), 42.0% (47 sample) were blew MRLs, while 16.0% (13) were at safety limits MRLs. While NAA residues that detected in vegetable samples was more than safety limit in 73 samples (66.0%), 29.0% (33) were blew MRLs, while 5.0% (6) were at safety limits MRLs. In most of analyzed samples 83 (74.0%) 2,4-D residues were above safety limits (MRLs), 22.0% (43) were blew MRLs, while 6.0% (7) were at safety limits MRLs. In most of analyzed samples 51 (45.0%) ethephon residues were above safety limits (MRLs), 44.0% (49) were blew MRLs, while 11.0% (12) were at safety limits MRLs. It worth mention, fruits and vegetable contained samples with PGRs residues above safety limits (MLR) in the following order: 2,4-D (74%) > NAA (66%) > Eth (45%) > Gib (42%).

Table 1. Levels of plant growth regulator residues of some fruits collected from Egyptian local markets.

Commodity	Number of samples	Number of contaminated samples	Detected Plant growth regulator	Minimum (ppm)	Maximum (ppm)	Mean (ppm)	MRL (ppm) EU(2010)
Pear	14	8	Gib	0.30	0.٣٢	٠.٣١	0.20
			NAA	٠.40	٠.80	٠.60	0.30
			2.4 D	0.٠5	0.٠٦	0.٠٦	0.01
			Eth	1.16	1.56	1.36	3.00
grapes	14	9	Gib	0.٢7	0.٣7	0.٣٢	0.20
			NAA	0.٠7	٠.١7	0.12	0.10
			2.4 D	0.21	0.41	0.31	0.50
			Eth	0.73	1.13	0.93	1.00
Apricots	14	9	Gib	0.16	0.25	0.21	0.20
			NAA	0.07	0.2	0.14	0.10
			2.4 D	3.80	6.20	5.00	5.00
			Eth	2.20	3.20	2.70	2.00
Peach	14	10	Gib	0.25	0.33	0.29	0.20
			NAA	0.09	0.32	0.21	0.20
			2.4 D	0.21	0.26	0.24	0.20
			Eth	0.42	0.61	0.52	0.50
Guavas	14	8	Gib	0.18	0.22	0.20	0.20
			NAA	0.07	0.17	0.12	0.10
			2.4 D	0.03	0.13	0.08	0.05
			Eth	0.71	1.11	0.91	2.00
Figs	14	9	Gib	0.18	0.26	0.22	0.20
			NAA	0.08	0.12	0.10	0.10
			2.4 D	0.18	0.25	0.22	0.20
			Eth	1.76	2.60	2.18	2.00
Plum	14	10	Gib	0.17	0.30	0.24	0.20
			NAA	0.05	0.45	0.25	0.10
			2.4 D	0.90	1.50	1.20	0.20
			Eth	2.10	3.10	2.60	2.00
Apples	14	9	Gib	0.22	0.28	0.25	0.20
			NAA	0.40	0.62	0.51	0.50
			2.4 D	0.05	0.09	0.09	0.01
			Eth	0.20	0.80	0.50	0.50
Date palm	14	8	Gib	0.12	0.27	0.20	0.20
			NAA	0.07	0.17	0.12	0.10
			2.4 D	0.03	0.06	0.05	0.05
			Eth	0.90	2.90	1.90	2.00
Mango	14	10	Gib	0.16	0.36	0.26	0.20
			NAA	0.17	0.27	0.22	0.20
			2.4 D	0.03	0.08	0.06	0.05
			Eth	1.40	2.80	2.10	2.00
Grape leaves	14	11	Gib	0.17	0.45	0.31	0.20
			NAA	0.08	0.8	0.44	0.10
			2.4 D	0.16	0.36	0.26	0.20
			Eth	1.40	3.40	2.40	2.00
Total	154	101					

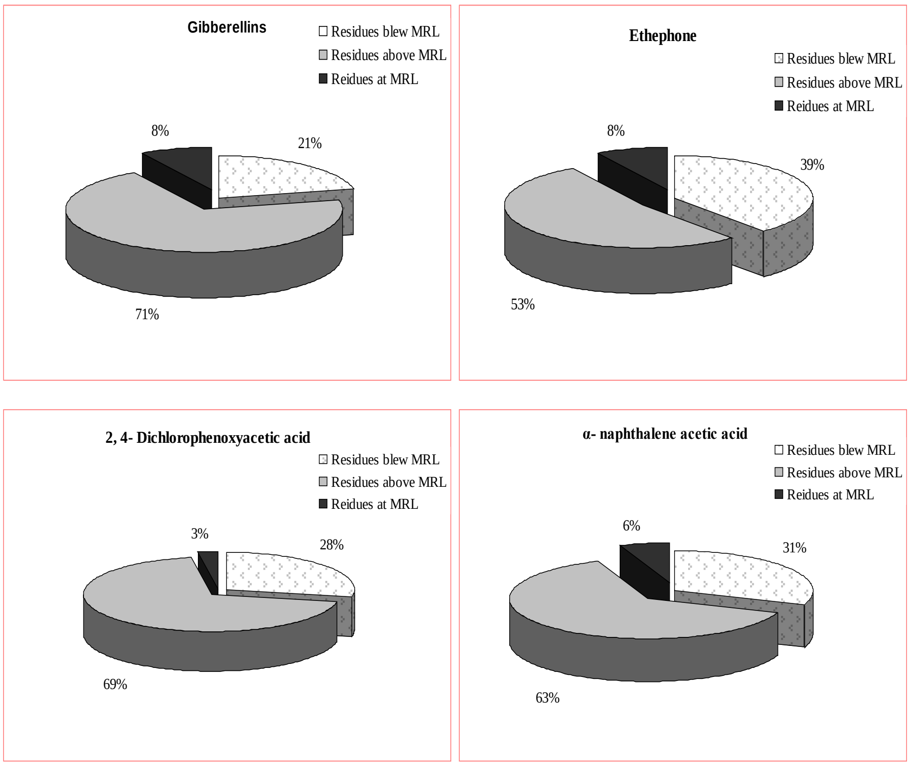


Figure 2. Number of non-contaminated and contaminated fruit samples with synthetic plant growth regulator compared to EU-MRLs.

Multiresidue Samples

Samples of fruits and vegetables: without, with one and multiresidue PGRs residues present in Figure 4. The obtained data observed that, most commonly detected in fruit samples were combination of three or four PGRs, combination % reached 22.0 and 42.9%, respectively. Whereas, most commonly detected in vegetable samples were combination of two or three or four PGRs, combination % reached 12.0, 13.4, and 34.8%, respectively.

Table 2. Levels of plant growth regulator residues of some vegetables collected from Egyptian local markets

Commodity	Number of samples	Number of contaminated samples	Detected Plant growth regulator	Minimum (ppm)	Maximum (ppm)	Mean (ppm)	MRL (ppm) EU (2010)
Carrot	14	8	Gib	0.18	0.28	0.23	0.20
			NAA	0.04	0.14	0.09	0.10
			2.4 D	0.05	0.09	0.07	0.08
			Ethop	0.08	0.18	0.13	0.05
Rocket	14	6	Gib	0.16	0.23	0.20	0.20
			NAA	0.05	0.11	0.08	0.10
			2.4 D	0.09	0.98	0.54	0.07
			Ethop	1.57	1.97	1.77	5.00
Cabbage	14	8	Gib	0.52	0.92	0.72	0.20
			NAA	0.19	0.79	0.49	0.10
			2.4 D	0.05	0.25	0.15	0.08
			Ethop	0.40	0.80	0.60	0.05
Molekhia	14	7	Gib	0.06	0.16	0.11	0.20
			NAA	0.05	0.15	0.10	0.10
			2.4 D	0.37	0.77	0.57	0.07
			Ethop	1.13	1.51	1.31	5.00
Lettuce	14	9	Gib	0.09	0.19	0.14	0.20
			NAA	0.06	0.16	0.11	0.10
			2.4 D	0.08	0.12	0.10	0.08
			Ethop	0.03	0.08	0.06	0.05
Parsley	14	7	Gib	0.08	0.12	0.1	0.20
			NAA	0.06	0.16	0.11	0.10
			2.4 D	0.05	0.15	0.10	0.07
			Ethop	0.66	1.06	0.86	5.00
Tomato	14	11	Gib	0.17	0.87	0.52	0.20
			NAA	0.75	0.95	0.85	0.10
			2.4 D	0.15	0.27	0.21	0.20
			Ethop	1.10	1.30	1.20	1.00
Cucumber	14	12	Gib	0.44	0.84	0.64	0.20
			NAA	0.12	0.32	0.22	0.10
			2.4 D	0.07	0.11	0.09	0.08
			Ethop	1.30	2.10	1.70	2.00
Total	112	68					

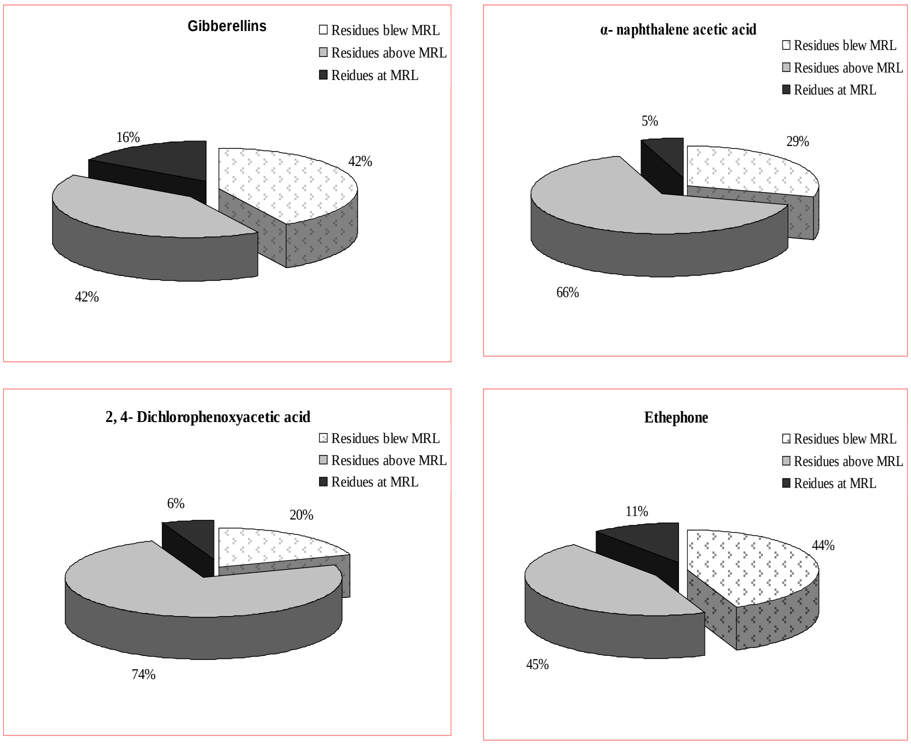
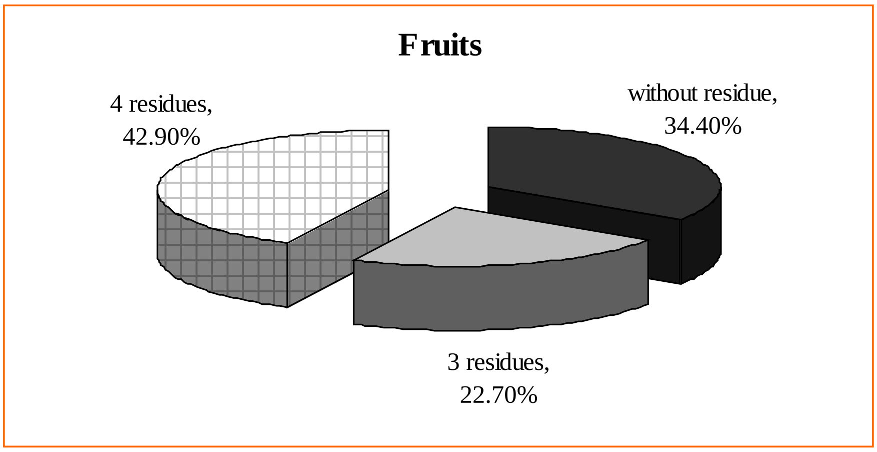


Figure 3. Number of non-contaminated and contaminated vegetable samples with synthetic plant growth regulator compared to EU-MRLs.



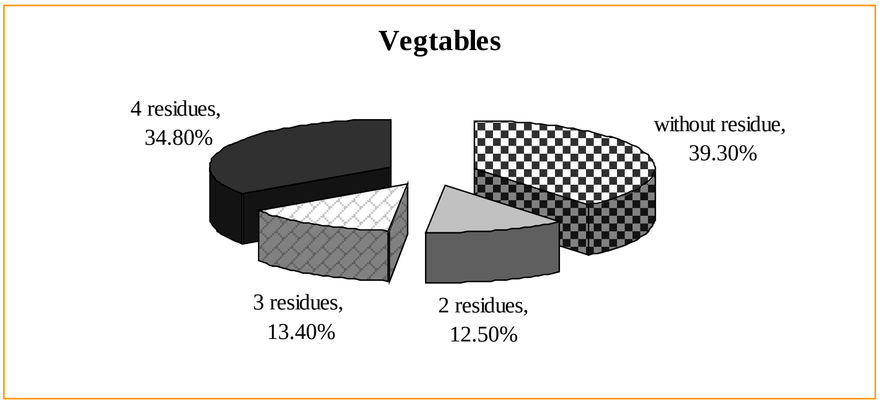


Figure 4. Samples of fruits and vegetables: without, with one and multiresidue synthetic plant growth regulators.

Risk of Exposure

In order to assess the risk of exposure of human health to the PGRs residues, first of all, the individual components of dietary intakes must be known WHO (1997), taking into account different age groups (children and adults), as it relates to body weight and nutritional prevention. Data pertaining to acute hazard index (aHI) for consumer were presented in Table 3. Based on the highest consumption and highest concentrations of PGRs residues detected in samples, data revealed that Gib had the hazard effect in fig, plum, and tomato for children whereas tomato for adult. In case NAA, hazard effect was observed in tomato for children only. Concerning the 2,4-D, hazard effect was showed in grape, apricot, and tomato for children whereas grape and tomato for adult. About the Eth, hazard effect was showed in all commodities except to carrot, cabbage, and lettuce for adult only. Health risk estimation for chronic effects (long term) associated with average PGRs residues are presented in Table (4). Data showed that the chronic intakes of the four considered PGRs residues are rather high compared to the ADI (mostly the *C*HI values were > 1%).

Table (3): Hazard index for acute effect associated with the highest PGRs residue in the some fruits and vegetables

Commodity	Consumer	Gib			NAA			2,4-D			Eth		
		Con	MRL	aHI	C	MRL	aHI	C	MRL	aHI	C	MRL	aHI
Pear	Chil	0.31	0.20	0.55	0.60	0.30	0.50	0.06	0.01	0.03	1.36	3.00	124.0٠
	Adul	0.31	0.20	0.23	0.60	0.30	0.22	0.06	0.01	0.01	1.36	3.00	55.0٠
grapes	Chil	0.32	0.20	0.43	0.12	0.10	0.14	0.31	0.50	2.60	0.93	1.00	33.0٠
	Adul	0.32	0.20	0.17	0.12	0.10	0.06	0.31	0.50	1.12	0.93	1.00	14.0٠
Apricots	Chil	0.21	0.20	0.07	0.14	0.10	0.02	5.00	5.00	2.00	2.70	2.00	10.0٠
	Adul	0.21	0.20	0.03	0.14	0.10	0.008	5.00	5.00	0.84	2.70	2.00	4.0٠
Peach	Chil	0.29	0.20	0.57	0.21	0.20	0.34	0.24	0.20	0.68	0.52	0.50	207.0٠
	Adul	0.29	0.20	0.23	0.21	0.20	0.14	0.24	0.20	0.28	0.52	0.50	90.0٠
Guavas	Chil	0.20	0.20	0.55	0.12	0.10	0.16	0.08	0.05	0.16	0.91	2.00	85.0٠
	Adul	0.20	0.20	0.23	0.12	0.10	0.08	0.08	0.05	0.08	0.91	2.00	35.0٠
Figs	Chil	0.22	0.20	1.10	0.10	0.10	0.16	0.22	0.20	0.68	2.18	2.00	85.0٠
	Adul	0.22	0.20	0.23	0.10	0.10	0.08	0.22	0.20	0.28	2.18	2.00	35.0٠
Plum	Chil	0.24	0.20	1.10	0.25	0.10	0.16	1.20	0.20	0.68	2.60	2.20	85.0٠
	Adul	0.24	0.20	0.23	0.25	0.10	0.08	1.20	0.20	0.28	2.60	2.20	35.0٠
Apple	Chil	0.25	0.20	0.72	0.51	0.50	0.54	0.09	0.01	0.02	0.50	0.50	13.0٠
	Adul	0.25	0.20	0.17	0.51	0.50	0.24	0.09	0.01	0.008	0.50	0.50	6.0٠
Date palm	Chil	0.20	0.20	0.60	0.12	0.10	0.18	0.05	0.05	0.20	1.90	2.20	90.0٠
	Adul	0.20	0.20	0.27	0.12	0.10	0.08	0.05	0.05	0.08	1.90	2.20	38.0٠
Mango	Chil	0.26	0.20	0.37	0.22	0.20	0.14	0.06	0.05	0.08	2.10	2.20	35.0٠
	Adul	0.26	0.20	0.17	0.22	0.20	0.06	0.06	0.05	0.03	2.10	2.20	15.0٠
Grape leaves	Chil	0.31	0.20	0.43	0.44	0.10	0.14	0.26	0.20	0.52	2.40	2.20	65.0٠
	Adul	0.31	0.20	0.20	0.44	0.10	0.06	0.26	0.20	0.24	2.40	2.20	28.0٠
Carrot	Chil	0.23	0.20	0.40	0.09	0.10	0.12	0.07	0.08	0.25	0.13	0.05	1.5٠
	Adul	0.23	0.20	0.17	0.09	0.10	0.04	0.07	0.08	0.08	0.13	0.05	0.5٠
Rocket	Chil	0.20	0.20	0.40	0.08	0.10	0.12	0.54	0.07	0.16	1.77	5.00	145.0٠
	Adul	0.20	0.20	0.17	0.08	0.10	0.04	0.54	0.07	0.08	1.77	5.00	62.0٠
Cabbage	Chil	0.72	0.20	0.40	0.49	0.10	0.12	0.15	0.08	0.20	0.60	0.05	1.5٠
	Adul	0.72	0.20	0.17	0.49	0.10	0.04	0.15	0.08	0.08	0.60	0.05	0.5٠
Molekhia	Chil	0.11	0.20	0.40	0.10	0.10	0.12	0.57	0.07	0.16	1.31	5.00	145.0٠
	Adul	0.11	0.20	0.17	0.10	0.10	0.04	0.57	0.07	0.08	1.31	5.00	60.0٠
Lettuce	Chil	0.14	0.20	0.40	0.11	0.10	0.12	0.10	0.08	0.12	0.06	0.05	1.5٠
	Adul	0.14	0.20	0.17	0.11	0.10	0.04	0.10	0.08	0.08	0.06	0.05	0.5٠
Parsley	Chil	0.10	0.20	0.40	0.11	0.10	0.12	0.10	0.07	0.16	0.86	5.00	145.0٠
	Adul	0.10	0.20	0.17	0.11	0.10	0.04	0.10	0.07	0.08	0.86	5.00	60.0٠
Tomato	Chil	0.52	0.20	8.70	0.85	0.10	1.30	0.21	0.20	5.20	1.20	1.00	370.0٠
	Adul	0.52	0.20	1.8	0.85	0.10	0.54	0.21	0.20	2.20	1.20	1.00	135.0٠
Cucumber	Chil	0.64	0.20	0.40	0.22	0.10	0.14	0.09	0.08	0.20	1.70	2.00	65.0٠
	Adul	0.64	0.20	0.20	0.22	0.10	0.06	0.09	0.08	0.08	1.70	2.00	28.0٠

Chil: children; Adul: adult; Con: concentration (µg/g); MRL: maximum residue levels (µg/g); aHI: Acute hazard index

Table (4): Health risk estimation for chronic effects associated with average PGRs residue

Commodity	Consumer	
	cHI %	Health risk
Pear	> 1	yes
grapes	> 1	yes
Apricots	> 1	yes
Peach	> 1	yes
Guavas	> 1	yes
Figs	> 1	yes
Plum	> 1	yes
Apple	> 1	yes
Date palm	> 1	yes
Mango	> 1	yes
Grape leaves	> 1	yes
Carrot	> 1	yes
Rocket	> 1	yes
Cabbage	> 1	yes
Molekhia	> 1	yes
Lettuce	> 1	yes
Parsley	> 1	yes
Tomato	> 1	yes
Cucumber	> 1	yes

cHI: chronic hazard index (%)

CONCLUSION

The purpose of this paper was to assess the concentration of synthetic plant growth regulator residues (PGRs) in fruits and vegetables and to estimate the potential health risks associated with the PGRs with regard to consumers to take preventive actions to minimize human health risks. It could be concluded from these data, that all synthetic plant growth regulators of which their residues were detected in the most different samples of fruits and vegetables are hazard. Data of acute hazard index revealed that Gib had the hazard effect in fig, plum, and tomato. In case of NAA, hazard effect was observed in tomato only. Concerning the 2,4-D, hazard effect was showed in grape, apricot, and tomato. About the Eth hazard effect it was showed in all commodities except carrot, cabbage, and lettuce. The chronic hazard index of the considered PGRs residues are high and rather than > 1%.

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تقييم متبقيات منظمات النمو النباتية فى الفواكه والخضراوات وتقدير مخاطرها الصحية للمستهلك فى منطقة الجيزة- مصر

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لقد اكتسبت منظمات النمو النباتية للفواكه والخضروات الاهتمام في جميع أنحاء العالم في السنوات الأخيرة بسبب تطبيقها على نطاق واسع في مجال الزراعة ومدى المخاطر التي تهدد صحة وسلامة المستهلكين .وكان الغرض من هذه الدراسة تقييم متبقيات منظمات النمو النباتية في الفواكه والخضروات وتقدير المخاطر الصحية المحتملة المرتبطة للمستهلكين لاتخاذ إجراءات وقائية للحد من المخاطر الصحية للإنسان .وقد تم استخدام جهاز الكرماتوجرفى لتحديد أربعة منظمات نمو نباتية مثل الجبرلينات وألفا نفتالين حمض الخليك و ٢-٤ داى كلورو فينوكسى اسيتك اسيد و الايثيفون في الفواكه والخضروات المنتجة محليا والتى تم شراؤها من سبعة أسواق رئيسية في محافظة الجيزة، مصر، خلال عام ٢٠١٤. واستنادا إلى التحليلات التى تمت فأنه لم تتكشف متبقيات منظمات النمو النباتية في ٣٤.٤٪ من عينات الفواكه و٣٩.٣٪ من عينات الخضراوات بينما وجدت متبقيات منظمات النمو النباتية في ٦٥.٦٪ من عينات الفواكه و٦٠.٧٪ من عينات الخضراوات وأظهرت النتائج وجود متبقيات منظمات النمو النباتية فوق الحدود الامنة في الترتيب التالي: جبريلليك (٧١٪) > 2،4-D (69٪) > نفثالين اسيتك اسيد (63٪) > إيثفون (٥٣٪) للفواكه في حين - D٢،٤ (74٪) > نفثالين اسيتك اسيد (66٪) > إيثفون (٤٥٪) >جبريلليك (٤٢٪) للخضروات .

وأظهرت البيانات الخاصة بمؤشر الخطر الحاد أن الجبريلليك كان له تأثير حاد في التين والبرقوق، والطماطم .وأن NAA لوحظ في الطماطم فقط .وفيما يتعلقD-4،2 فقد أظهرت تأثيرة في العنب، والمشمش، والطماطم. ، وقد أظهرت النتائج ان للايثيفون تأثير خطر حاد في جميع السلع باستثناء الجزر، والكرنب، والخس . واضحت بيانات مؤشر الخطر المزمن لمتبقيات منظمات النمو النباتية فى عينات الفواكة والخضرواوات تعتبر مرتفعة نوعا ما حيث انها تعدت 1%.