Middle East Journal of Applied Sciences
ISSN 2077-4613
Volume : 08 | Issue :02 |April-June| 2018
Pages: 669-679

Monitoring and Risk Assessment of Pesticide Residues in Some Vegetables in Egypt

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Received: 08 Mar. 2018 / Accepted: 17 May 2018 / Publication date: 20 June 2018

ABSTRACT

Samples of some vegetables were analyzed for pesticide residues using the accredited (QuEChERS) method. The method allowed the determination of 450 compounds of different pesticide chemical groups. LC-MS/MS and GC–MS/MS were used for residues quantification. In a total number of 103 pepper samples and 104 cucumber samples, no pesticides residues were detected in 20 pepper samples (19.42%) and 29 cucumber samples (27.88%), while 83 pepper samples (80.58%) and 75 cucumber samples (72.12%) had detectable pesticide residues, while 17 cucumber samples and 29 pepper samples exceeding the MRLs levels established by the Codex Alimentarius Commission. The hazard index (HI %), representing the long – term risk assessment was in the range of 0.0144%–4.1869% in cucumber samples and 0.1273%– 4.7118 % in pepper samples of the ADI's. The highest exposure was observed for Methomyl, followed by Famoxadone, at 4.1869% and 0.6909% in cucumber samples and the highest exposure was observed for Profenofos, followed by Methomyl, at 4.7118% and 3.4181% in pepper samples of ADI respectively.

Key words: Pesticide residues, risk assessment, exposure.

Introduction

Vegetables are essential component of healthy diet. They constitute a major source of vitamins, minerals and fibers. However, vegetables can also be a source of toxic pesticide residues that might cause significant harm to consumers (Knezevic and Serdar, 2008). Pesticides play an important role in preventing crop losses and controlling vectors of diseases (Sharp and Cellas 2005). Nevertheless, the extensive uses of pesticides have raised serious concern for the side effects inflicted on consumers (Abinash and Singh, 2009, Darko and Akoto, 2008, Solecki *et al.,* 2005, Juraske *et al.,* 2009).

It is already well established that long exposure to low doses has been linked to human risks such as immunity suppression, hormone disruption, diminished intelligence, reproductive abnormalities and cancer (Wiles *et al.,* 1998).

The present work is portraying the result of pesticide residue monitoring program in vegetables conducted in Egypt, and the use of health index module to reflect possible risks to consumers.

Material and Methods

Sampling:

A total of one hundred three pepper samples and one hundred four cucumber samples were collected from nine Egyptian local markets located in eight governorates (Great Cairo, Fayoum, Gharbia, Giza, Monufia, Ismailia, Sharkiya, and Qalyubia) during 2012. For residue analysis, 2 kg of each commodity were thoroughly mixed, and prepared according to the generally recommended method; (Codex Alimentarius Commission, 1993). Samples were analyzed immediately upon their arrival at the laboratory, or they were stored at 0–5°C for 4 days before analysis. Samples were analyzed for detection of 450 pesticides.

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Pesticide Residues Analysis:

The standard method European Committee for Standardization/Technical Committee 275 (2007) for foods of plant origin: prEN 15662 (QuEChERS) was followed.

The determination of residues carried out using GC-MS/MS and LC-MS/MS after acetonitrile extraction/partitioning and cleanup by dispersive SPE.

The homogeneous sample is extracted in frozen condition with the help of acetonitrile. After addition of magnesium sulfate, sodium chloride and buffering citrate salts (pH 5 to 5.5); the mixture is shaken intensively and centrifuged for phase separation. An aliquot of the organic phase is cleaned-up by dispersive solid phase extraction (D-SPE) employing bulk sorbent as well as magnesium sulfate for the removal of residual water. Following cleanup with amino-sorbents (e.g. primary secondary amine sorbent, PSA) extracts were acidified by adding a small amount of formic acid, to improve the storage stability of certain base-sensitive pesticides. The final extract can be directly employed for GC- and LC-based determinative analysis. Quantification was performed using an internal standard, which was added directly before injection in GC-MSD system. The method validated 450 compounds using LC-MS/MS and GC-MS/MS. The detection and confirmation of pesticide residues in the samples was made using GC-MS/MS and LC-MS/MS.

Quality Assurance:

An analytical method and instruments were carefully validated as a part of the laboratory quality assurance system and were audited and accredited by the Center of Metrology and Accreditation Finnish Accreditation Service (FINAS) ISO/IEC Guide 17025. The criteria of quality assurance were followed to determine the performance of the standard method**.** The average recoveries tests on different types of pesticides at different concentration levels varied between 70-120%. The reproducibility expressed as relative standard deviation was less than 25%. The limit of quantification started at 0.01 mg/kg and up depending on the pesticide type and detected module. The measurement uncertainty expressed as expanded uncertainty and in terms of relative standard deviation (at 95% confidence level) is lower than the default value set by EU (± 50%).

Blank samples were fortified with the pesticides mixture and analyzed as a normal sample with set of samples. The results were recorded on control charts. Repeated analysis of old samples was regularly carried out to control reproducibility.

Apparatus:

(a)LC-MS/MS System

Agilent 1200 series liquid chromatography system equipped with Applied Biosystems (API 4000 Qtrape) tandem mass spectrometers with electrospray ionisation (ESI) interface. Separation was performed on a C18 column ZORBAX Eclipse XDBC18 4.6 mm x 150 mm, 5 µm particle sizes. The injection volume was 25 µl. A mobile phase was at 0.3 ml/min flow rate, in which one reservoir contained 10 mM ammonium formate solution in MeOH:H_2O (1:9, v/v). The ESI source was used in the positive mode, and Nitrogen was used as nebulizer gas, curtain gas, heater gas and collision gas according to manufacturer's settings; source temperature was 300oC, ion spray potential 5500 V,decluster potential and collision energy were optimized using a Harvard apparatus syringe pump. The Multiple Reaction Monitoring Mode (MRM) was used in which one MRM was used for quantification and other was used for confirmation.

(b) GC-MS/MS:

Agilent Gas Chromatograph 7980A equipped with tandem mass spectrometer 7000B Quadrupole, EI source was used to perform analysis by using HP-5MS 5% phenyl methyl siloxane capillary column (30 m length x 0.25 mm id x 0. 25 µm film thickness). Samples were injected in a splitless mode and helium was used as carrier gas (1 ml/min). Injector temperature was 250°C, transfer line temperature was 285°C, ion source temperature was 280°C and quadrupole temperature was 150°C.

The GC oven temperature was programmed to initially held at 70°C for 2 min then increased to 150°C at 25°C/min (held for 0 min), and raised to 200°C at the rate of 3°C/min (held for 0 min), then went up from 200 to 280°C at 8°C/min (held for 10 min). This resulted in a total run time of 42 min and complete separation of all the analysts.

Reagents:

Solvent and chemicals described in the standard method CEN 275, 2007.

Pesticides reference standards:

All reference materials are certified provided by Dr. Ehrenstorfer Gmbh, Gogginger Str. 78 D-8900 Augoburg.

Risk Assessment:

Risk assessment is calculated by comparing the concentrations of residues detected, with the established acceptable daily intake (ADI). The level of residue concentration in a vegetable species was determined as the arithmetic mean of all the results obtained. Residues higher than the Limit of Quantification (LOQ) were used in the calculation of exposure in order to avoid overestimation of Estimated Daily Intake (EDI). The EDI (mg kg $^{-1}$ bw^{-1} day) of each pesticide residue was calculated by multiplying the mean concentration of pesticide residue (mg kg^{-1}), the food consumption rate (kg day^{-1}) and divided by body weight, assuming an average adult's body weight of 60 kg. Meanwhile, the estimated daily intake (EDI) of pesticide residues was calculated as follows:

$$EDI = \Sigma RLix\ Fi / Bw$$

RLi = residue level of the vegetable;
Fi = food consumption data;
BW= Body weight.

The total exposure to a given pesticide residue was obtained by summing upexposures from all pesticide residues in the vegetable species, (FAO/WHO, 2010). The food consumption figures used were based on the data issued by WHO / Global Environment Monitoring System–Food Contamination; Monitoring and Assessment Program average consumption, cluster C diets (FAO/WHO, 2012) (GEMS/Foods) (2012). If data from food balance sheets were not available for any particular vegetable, then the consumption level for a similar food is used, (FAO/WHO, 1997).

WHO/GEMS/FOODS cluster C. Food balance sheet of regional diet. In this study the hazard index (HI) was used to indicate the risk assessment. HI was obtained by dividing the estimated daily intake (EDI) by the relevant acceptable daily intake (Lozowicka *et al.,* 2013).

HI= (EDI/ADI)*100%.

When the hazard index (HI) is >100; the food involved should be considered as a risk to the consumers, while if the index is % <100, this would indicate that the food involved is considered acceptable.

Results and Discussion

Pesticide residues

Pesticide residues are substances that remain in or on air, water, soil, or food following its use. Even food grown without direct pesticide use can still contain residues due to spray drift from nearby farms, long range air transport, or existing groundwater or soil contamination. (Magkos *et al.,* 2003).

Table (1) and figure (1) shows the residue level of different pesticides detected and the percentage of samples with residues level exceeding MRL in cucumber samples. No pesticide residues were detected in 29 cucumber samples (27.88%), on the other hand, a total number of 75 cucumber samples (72.12%) had detectable pesticide residues, 17 cucumber samples (22.67%) out of 75 cucumber samples exceeding the MRLs established by the Codex Alimentarius.

Table 1: Total analyzed samples, contamination %, frequency, minimum, maximum and mean of pesticide residues monitored in Cucumber in Egypt during 2012

Total analyzed samples	Number of Contaminated samples	Contamination %	The detected pesticide	frequency	Min mg/kg	Max mg/kg	Mean mg/kg	MRL mg/kg	No. of violated	violated %	Total violated samples	Total violated samples %
104	75	72.12%	Acetamiprid	16	<LOQ	0.09	0.026	0.3	0	0.0%	17	22.67%
			alpha-HCH	1	0.01	0.01	0.01	-	-	-		
			Azoxystrobin	6	<LOQ	0.06	0.021	1	0	0.0%		
			Benalaxyl	2	0.02	0.03	0.025	0.05	0	0.0%		
			Bifenthrin	1	0.04	0.04	0.04	0.1	0	0.0%		
			Boscalid	2	0.01	0.03	0.02	3	0	0.0%		
			Cadusafos	1	0.01	0.01	0.01	0.01	0	0.0%		
			Carbendazim	15	<LOQ	0.22	0.063	0.1	4	5.3%		
			Chlorfenapyr	4	<LOQ	0.03	0.016	0.01	2	2.7%		
			Chlorothalonil	1	0.03	0.03	0.03	3	0	0.0%		
			Chlorpropham	3	<LOQ	<LOQ	<LOQ	0.01	0	0.0%		
			Chlorpyrifos	25	<LOQ	0.21	0.022	0.05	2	2.7%		
			Cymoxanil	1	0.01	0.01	0.01	0.5	0	0.0%		
			Cypermethrin	1	0.01	0.01	0.01	0.07	0	0.0%		
			Dicofol	1	0.05	0.05	0.05	0.02	1	1.3%		
			Dimethomorph	5	<LOQ	0.03	0.014	0.5	0	0.0%		
			Dinotefuran	1	0.02	0.02	0.02	0.5	0	0.0%		
			Ethion	2	<LOQ	0.02	0.013	0.01	1	1.3%		
			Famoxadone	5	0.01	0.09	0.03	0.2	0	0.0%		
			Fenpropathrin	1	0.03	0.03	0.03	0.01	1	1.3%		
			Fenpyroximate	2	0.01	0.01	0.01	0.3	0	0.0%		
			Fluopicolide	6	<LOQ	0.03	0.016	0.5	0	0.0%		

Table 1: *Continued*

Total analyzed samples	Number of Contaminated samples	Contamination %	The detected pesticide	frequency	Min mg/kg	Max mg/kg	Mean mg/kg	MRL mg/kg	No. of violated	violated %	Total violated samples	Total violated samples %
104	75	72.12%	Flusilazole	2	<LOQ	0.01	0.008	0.01	0	0.0%	17	22.67%
			Hexythiozox	1	0.01	0.01	0.01	0.5	0	0.0%		
			Imidacloprid	6	<LOQ	0.01	0.008	1	0	0.0%		
			Indoxacarb	1	<LOQ	<LOQ	<LOQ	0.5	0	0.0%		
			Iprodione	2	0.02	0.1	0.06	2	0	0.0%		
			Kresoxim-methyl	1	<LOQ	<LOQ	<LOQ	0.05	0	0.0%		
			Lambda-Cyhalothrin	4	<LOQ	0.03	0.013	0.05	0	0.0%		
			Malathion	1	0.03	0.03	0.03	0.2	0	0.0%		
			Mandipropanid	1	0.03	0.03	0.03	0.2	0	0.0%		
			Metalaxyl	30	<LOQ	0.56	0.072	0.5	1	1.3%		
			Methomyl	5	0.03	2.5	0.606	0.1	3	4.0%		
			Oxamyl	3	0.09	0.79	0.34	2	0	0.0%		
			Penconazole	2	0.01	0.03	0.02	0.1	0	0.0%		
			Phenthoate	2	0.01	0.01	0.01	-	-	-		
			Procymidone	1	0.07	0.07	0.07	0.01	1	1.3%		
			Propamocarb	24	0.01	1.7	0.403	5	0	0.0%		
			Propargite	3	0.01	0.02	0.013	0.01	1	1.3%		
			Prothioconazole	1	0.49	0.49	0.49	0.02	1	1.3%		
			Thiacloprid	1	<LOQ	<LOQ	<LOQ	0.3	0	0.0%		
			Thiamethoxam	3	0.01	0.02	0.017	0.5	0	0.0%		
			Triadimenol	2	0.01	0.01	0.01	0.2	0	0.0%		

MRL: Maximum Residue limit according to codex

Table 2: Total analyzed samples, contamination %, frequency, minimum, maximum and mean of pesticide residues monitored in pepper in Egypt during 2012

Total analyzed samples	Number of Contaminated samples	Contamination %	The detected pesticide	frequency	Min mg/kg	Max mg/kg	Mean mg/kg	MRL mg/kg	No. of violated	violated %	Total violated samples	Total violated samples %
103	83	80.58%	Abamectin	1	<LOQ	<LOQ	<LOQ	0.02	0	0.0%	29	34.94%
			Acetamiprid	11	<LOQ	0.16	0.035	0.3	0	0.0%		
			alpha-HCH	2	<LOQ	0.01	0.008	-	-	-		
			Azoxystrobin	3	<LOQ	0.17	0.062	3	0	0.0%		
			Boscalid	7	<LOQ	0.4	0.074	3	0	0.0%		
			Bupirimate	3	0.02	0.05	0.033	2	0	0.0%		
			Carbendazim	19	<LOQ	0.66	0.130	0.1	10	12.0%		
			Chlorfenapyr	5	<LOQ	0.11	0.039	0.01	3	3.6%		
			Chlorothalonil	1	0.01	0.01	0.010	7	0	0.0%		
			Chlorpropham	1	0.04	0.04	0.040	0.01	1	1.2%		
			Chlorpyrifos	31	<LOQ	0.76	0.073	2	0	0.0%		
			Cyfluthrin	1	0.14	0.14	0.140	0.2	0	0.0%		
			Cypermethrin	8	<LOQ	0.09	0.034	0.1	0	0.0%		
			Cyproconazole	1	0.08	0.08	0.080	0.05	1	1.2%		
			Diazinon	1	0.08	0.08	0.080	0.05	1	1.2%		
			Dimethomorph	1	0.01	0.01	0.010	1	0	0.0%		
			Ethion	4	0.01	0.05	0.023	0.01	2	2.4%		
			Famoxadone	1	0.02	0.02	0.020	0.01	1	1.2%		
			Fenarimol	4	<LOQ	0.04	0.021	0.5	0	0.0%		
			Fenpropathrin	2	<LOQ	0.03	0.018	1	0	0.0%		
			Fludioxonil	1	<LOQ	<LOQ	<LOQ	1	0	0.0%		
			Flusilazole	6	<LOQ	0.04	0.018	0.01	3	3.6%		

Table 2: *Continued*

Total analyzed samples	Number of Contaminated samples	Contamination %	The detected pesticide	frequency	Min mg/kg	Max mg/kg	Mean mg/kg	MRL mg/kg	No. of violated	violated %	Total violated samples	Total violated samples %
103	83	80.58%	Flutolanil	1	0.01	0.01	0.010	0.01	0	0.0%	29	34.94%
			Imidacloprid	2	0.05	0.06	0.055	1	0	0.0%		
			Indoxacarb	2	<LOQ	0.01	0.008	0.3	0	0.0%		
			Kresoxim-methyl	3	<LOQ	0.01	0.008	0.8	0	0.0%		
			Lambda-Cyhalothrin	6	0.01	0.06	0.027	0.3	0	0.0%		
			Malathion	4	<LOQ	0.04	0.016	0.1	0	0.0%		
			Metalaxyl	9	<LOQ	0.07	0.027	1	0	0.0%		
			Methamidophos	1	0.03	0.03	0.030	0.01	1	1.2%		
			Methomyl	11	0.01	1.34	0.183	0.7	1	1.2%		
			Methoxyfenozide	2	0.02	0.05	0.035	2	0	0.0%		
			Myclobutanil	4	0.01	0.04	0.023	0.5	0	0.0%		
			Pendimethalin	2	<LOQ	0.01	0.008	0.05	0	0.0%		
			Phenthoate	1	<LOQ	<LOQ	<LOQ	-	-	-		
			Piperonylbutoxide	2	0.01	0.02	0.015	2	0	0.0%		
			Profenofos	23	<LOQ	4.3	0.378	0.01	12	14.5%		
			Propamocarb	1	0.05	0.05	0.050	3	0	0.0%		
			Propargite	1	0.02	0.02	0.020	0.01	1	1.2%		
			Propiconazol	2	<LOQ	0.03	0.018	0.05	0	0.0%		
			Pyridaben	1	0.02	0.02	0.020	0.5	0	0.0%		
			Spinosad	2	<LOQ	<LOQ	<LOQ	0.3	0	0.0%		
			Thiabendazole	2	<LOQ	<LOQ	<LOQ	0.05	0	0.0%		
			Thiobencarb	2	<LOQ	0.01	0.008	0.01	0	0.0%		
			Thiophanate-methyl	1	0.04	0.04	0.040	0.1	0	0.0%		
			Triflumzole	1	<LOQ	<LOQ	<LOQ	0.1	0	0.0%		

The violated compounds in cucumber samples were Carbendazim, Chlorfenapyr, Chlorpyrifos, Dicofol, Ethion, Fenpropathrin, Metalaxyl, Methomyl, Procymidone, Propargite and Prothioconazole. The highest frequently detected pesticide was Metalaxyl, followed by Chlorpyrifos and Propamocarb.

Table (2) and figure (2) shows the residue level of different pesticides detected and the percentage of samples with residues level exceeding MRL in pepper samples. No pesticide residues were detected in 20 pepper samples (19.42%), on the other hand, a total number of 83 pepper samples (80.58%) had detectable pesticide residues, 29 pepper samples (34.94%) out of 83 pepper samples exceeding the MRLs established by the Codex Alimentarius.

The violated compounds in pepper samples were Carbendazim, Chlorfenapyr, Chlorpropham, Cyproconazole, Diazinon, Ethion, Famoxadone, Flusilazole, Methamidophos, Methomyl, Profenofos and Propargite. The highest frequently detected pesticide was Chlorpyrifos, followed by Profenofos and Carbendazim.

The data showed that monitored vegetables in 2012 recorded low contamination with different pesticides in contrary with data represented by Gad Alla *et al.,* (2015). Similar trend of results was also reported by Mi-Ra *et al.* (2011) who conducted a monitoring study for vegetables in Korea and indicated that exceeding of MRL's is rather common in vegetables.

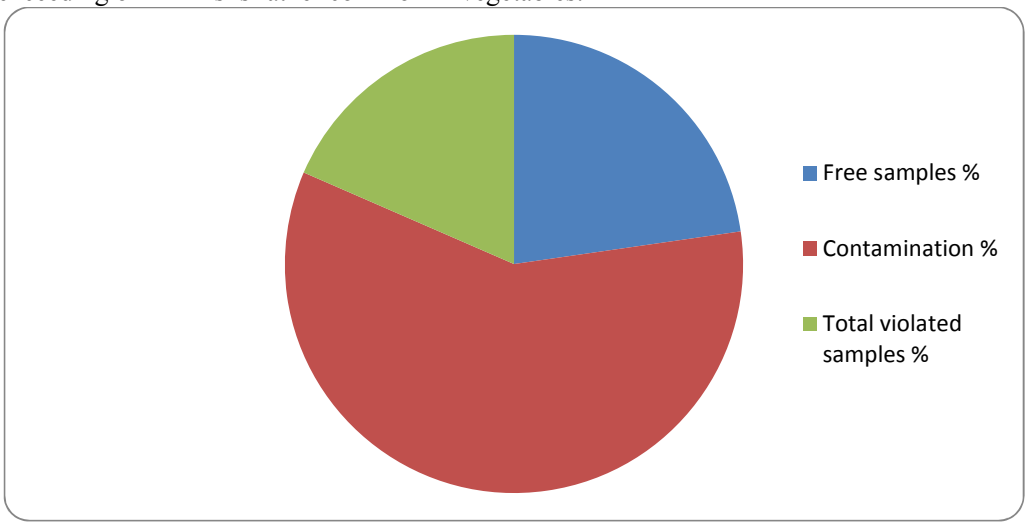

Fig. 1: The contamination and the violation percentages in Cucumber samples in Egypt during 2012

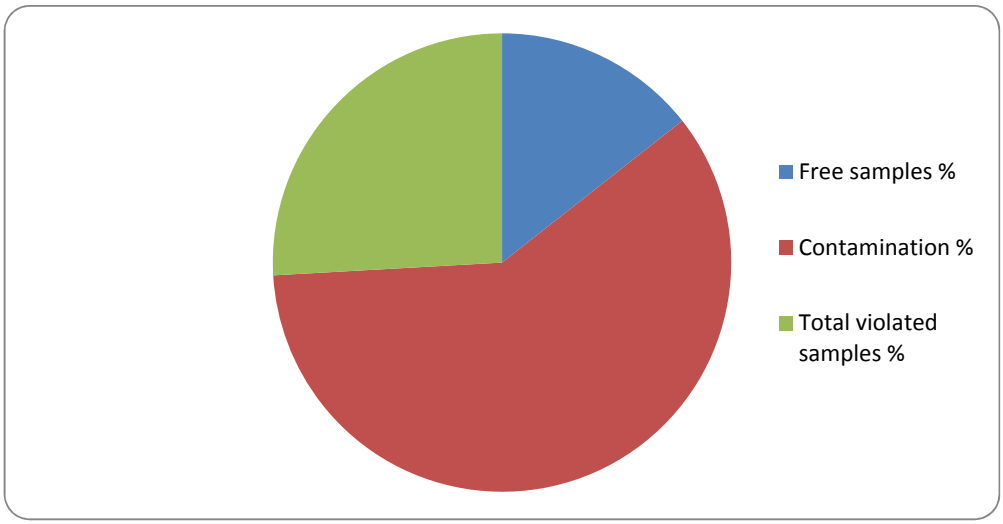

Fig. 2: The contamination and the violation percentages in Pepper samples in Egypt during 2012

Dietary exposure and dietary risk assessment:

Tables 3 and 4 showed the pesticides, which were the most frequently detected in the samples, were chosen for the dietary intake assessment; the chronic risk assessment is performed for all commodities. The average pesticide residues levels were calculated by using residue data from the monitoring data. The results of the EADI calculation are reported separately for each pesticide in an exposure assessment. If the ADI was not exceeded in any commodity, a chronic consumer risk can be excluded.

As shown by the results in table (3), the intake of pesticide residues does not exceed the ADI in any case. The hazard index ranges from 0.0144% of the ADI for the Azoxystrobin to 4.1869% of the ADI for the Methomyl.

As shown by the results in table (4), the intake of pesticide residues does not exceed the ADI in any case. The hazard index ranges from 0.1273% of the ADI for the Metalaxyl to 4.7118% of the ADI for the Profenofos.

It is clear from the previous data of risk assessment of pesticide residues in studied vegetables (cucumber and pepper) that no risk will be found from consuming these types of studied vegetables. These results are in compatable with Gad Alla *et al.,* (2015).The present results showed that, the long-term exposure of the Egyptian consumers to pesticide residues through the consumption of raw vegetables does not associate with health risk. However, it should be borne in mind that the current study is limited to a small group of vegetables. Moreover, the estimated risk assessment via long-term exposure is based on toxicological evaluation of the single compounds and not based on an evaluation of cumulative exposure to multiple pesticide residues in crops.

Pesticides can have a cumulative "toxic loading" effect both in the immediate and long term, and each person accumulates and responds to chemicals in a way that is biochemically and biographically unique. From birth, we build up a chemical "body burden" that reflects a combination of childhood and workplace exposures, pesticide residues on food, chemicals in home and personal care products and the quality of air and water in our communities.

The process of dietary pesticide risk assessment has been presented and three major components of the process estimation of pesticide residue levels, estimation of food consumption patterns, and characterization of risk based on a comparison of exposure estimates with toxicological criteria have been identified. Each component of the process is subjected to considerable uncertainty that may compromise the accuracy of the final risk assessment. In estimating pesticide residue levels, common practices range from highly theoretical models assuming that all residues are present at a predetermined level (typically at the tolerance level) to the use of market basket survey data obtained at the time the food is ready for consumption.

Table 3: Acceptable daily intake the most frequently detected pesticide residues and the estimated hazard index % in the cucumber 2012.

The detected pesticide	Mean mg/kg	food consumption g/day	EADI mg/kg.bw /day	ADI mg/kg bw	Hazard Index %
Acetamiprid	0.026	82.91	0.0000358412	0.07	0.0512%
Azoxystrobin	0.021	82.91	0.0000287881	0.2	0.0144%
Carbendazim	0.063	82.91	0.0000870551	0.03	0.2902%
Chlorpyrifos	0.022	82.91	0.0000306766	0.01	0.3068%
Dimethomorph	0.014	82.91	0.0000193456	0.1	0.0193%
Famoxadone	0.03	82.91	0.0000414548	0.006	0.6909%
Fluopicolide	0.016	82.91	0.0000218789	0.08	0.0273%
Imidacloprid	0.008	82.91	0.0000103637	0.06	0.0173%
Metalaxyl	0.072	82.91	0.0000994916	0.08	0.1244%
Methomyl	0.606	82.91	0.0008373875	0.02	4.1869%
Propamocarb	0.403	82.91	0.0005561856	0.4	0.1390%

Table 4: Acceptable daily intake the most frequently detected pesticide residues and the estimated hazard index % in the pepper 2012.

The detected pesticide	Mean mg/kg	food consumption g/day	EADI mg/kg.bw /day	ADI mg/kg bw	Hazard Index %
Acetamiprid	0.035	224.47	0.0001309436	0.07	0.1871%
Boscalid	0.074	224.47	0.0002752487	0.04	0.6881%
Carbendazim	0.13	224.47	0.0004863618	0.03	1.6212%
Chlorfenapyr	0.039	224.47	0.0001459085	0.015	0.9727%
Chlorpyrifos	0.073	224.47	0.0002733522	0.01	2.7335%
Cypermethrin	0.034	224.47	0.0001286053	0.02	0.6430%
Flusilazole	0.018	224.47	0.0000685895	0.007	0.9798%
Lambda-Cyhalothrin	0.027	224.47	0.0000997665	0.02	0.4988%
Metalaxyl	0.027	224.47	0.0001018450	0.08	0.1273%
Methomyl	0.183	224.47	0.0006836274	0.02	3.4181%
Profenofos	0.378	224.47	0.0014135397	0.03	4.7118%

Risk of adverse health effects is a function of pesticide toxicity and exposure. Exposure to a pesticide determines the dose and the pesticide's toxicity determines the potency of the dose. For pesticides that do not cause cancer, there is a dose below which there will be no effect. For pesticides that do not cause cancer, a no effect threshold has been determined for each pesticide, which is inversely related to its potency.

For pesticides that may cause cancer the probability that exposure will result in cancer is related to dose, the greater of exposure the greater of cancer probability. In each case risk is directly related to exposure, as exposure determines dose. If exposure is low enough the risk of adverse health effects is nil.

The Egyptian Organizations of Standardization should sets and revise the Egyptian maximum residue levels according risk exposure data and Egyptian food habit consumption, what it calls an "approved usage" level of a pesticide - essentially a safety limit on how much can make its way into the food chain. However, the approved usage level is set down for adults, potentially putting children at risk.

Currently, there is very limited data on Egyptian dietary pesticide exposure levels, and no data on the relative health risks and benefits of consuming organically- versus conventionally-grown food. Available data suggest that organic food contains fewer synthetic pesticide residues than conventional food, and eating an organic diet can result in lower exposures to some pesticides. However, given the current weight-of-evidence, it cannot be concluded based on its potential for reduction of exposure to pesticides that an organic diet provides greater health benefits than a conventional diet, although organically-grown food may provide other perceived benefits to consumers.

Egypt really need more research to quantify Egyptian dietary risk exposure data and other sources of pesticide exposures among different segments of the Egyptian population, also potential health effects from low-level dietary pesticide exposures, and the relative risks and benefits of an organic versus conventional diet. In particular, there remain significant gaps in scientific knowledge with respect to differences in pesticide residue (synthetic and natural), microbial pathogen, mycotoxin, and natural toxin levels in organically-grown versus conventionally-grown food.

Conclusion

From the calculated data of risk exposure according to monitoring of pesticide residues in Egyptian vegetables all the contaminated samples including that exceeded MRL was about 5% of the Acceptable Daily Intake (ADI) which insure that no risk will be found from consuming these types of vegetables.

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