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DIETARY INTAKE OF SOME ORGANOPHOSPHOURS INSECTICIDES IN SOME VEGETABLE CROPS IN EGYPT, A PRELIMINARY CASE STUDY

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ABSTRACT

A Total of 178 samples of commonly consumed vegetables were collected from seven different Egyptian governorates in 2007 and onward. A multiresidue method was used for analysis and the pesticides determined by gas chromatography. The Twenty nine organophosphorus (OP) pesticides were tested with validated analytical method using Gas chromatography, GC-NPD. Overall, 87% of the vegetables samples had no detectable organophosphorus pesticides. Of the analysed samples, 13.5% contained detectable residues, of which 4.5% exceeded MRL's.The obtained monitoring results showed that 4 out of 29 organophosphorus pesticides were detected in the analysed vegetable samples. The frequencies and percentages of detected residues were chlorpyrifos detected in 12 samples with percentage 6.7 % followed by profenofos detected in 11 samples with percentage 6.2%, then ethion and chlorpyrifos-Me detected in 3 and 2 samples with percentages 1.7%, 1.1% respectively. Risk assessments were also performed by calculating estimated daily intake (EDI) comparing the figures with acceptable daily intake (ADI). The intakes of OP pesticides were generally lower than 100% of the Acceptable Daily Intakes (ADIs). Tomato is the most vegetables contribution of the highest OP intake. The highest intake was that of profenofos 59.62 ug/ person followed by chlorpyrifos 55.62 ug/person, chlorpyrifos-Me, 15.34 ug/person and then ethion 12.98 ug/person, based on GEMS/food consumption rate.

Keywords: Pesticides Residues, Organophosphorus,OP, Vegetables, ADI, EDI, MRL, intake

INTRODUCTION

Organophosphorous insecticides (OPs) is the largest and most diverse group of insecticides known, with some 100,000 compounds synthesized and tested. Organophosphates are characterized by remarkable diverse toxicity to animal life, persistence, selectivity, and use patterns. These chemicals prevent normal transmission of nerve impulses, creating hyperactivity, tremors, convulsions, paralysis, and death. Among higher mammals symptoms of poisoning include also, nausea, salivation, giddiness, tearing, myosis, coma, and convulsion.

Organophosphate pesticides are widely used in agriculture and animal production for the control of various insect pests in many developing countries.

Most OP's are slightly soluble in water with high oil–water partition coefficients and a low vapour pressures (WHO, 1986). Majority of OP are liquids of comparatively low volatility, (except dichlorvos), and they all undergo degradation by hydrolysis, yielding non-toxic, water-soluble products. Toxic hazards of OP are therefore essentially short-term in contrast to that of the persistent organochlorine pesticides. Organophosphorus pesticides however have higher acute toxicities than chlorinated pesticides but they have an advantage of being more rapidly degraded in the environment. Their toxicological effects are mostly due to the inhibition of acetylcholinesterase in the nervous system, resulting in respiratory, myocardial and neuromuscular transmission impairment (Goh et al., 1990). WHO/FAO (1990) estimated an annual worldwide total of 3 million cases of acute and severe pesticide poisoning with some 220,000 deaths. The majority of these cases of poisoning and deaths occur in the developing countries, although far greater quantities of pesticides are used in the developed countries (Bhanti et al., 2004). Recent data reveals that the largest proportion of human acute toxicity of pesticides is due to organophosphorus pesticides (Ecobichon, 2001).

Acute toxic effects of pesticides on animals and humans are easily recognized, but the effects that result from long-term exposure to low doses are often difficult to distinguish. In particular, the effects of a regular intake of pesticide residues in food are hard to detect and quantify. An exposure or risk assessment is necessary in order to ascertain the effects due to regular intake of pesticide residues in food. Several indices of residue levels can be used to predict pesticide residue intake. The Maximum Residue Limits (MRL) is one such index and represents the maximum concentration of a pesticide residue (mg/kg) that the Codex Alimentarius Commission recommends be legally permitted in food commodities and animal feeds. The Acceptable Daily Intake (ADI) which is the estimated amount of a substance in food (expressed on a body-weight basis) that can be ingested daily over a lifetime without appreciable health risk to the consumer could also be used to predict the dietary intake of pesticide residues. The estimated dietary intake of a pesticide residue in a given food is obtained by multiplying the residue level in the food by the amount of that food consumed. The Estimated Average Daily Intake (EADI) of pesticide residues should be less than its established ADI (WHO, 1997).

In Egypt, several OP compounds are registered and used since many years for pest control and also in hygienic purposes. Recently, some of these toxic chemicals are either banned or allowed under restricted use only. Due to high demand for farm produce and low perception of the toxic effects of pesticide residues in food (Amoah et al., 2006; Bhanti and Taneja, 2007) some farmers do not observe the waiting interval for the residues to wash off after spraying before harvesting. Increased use of OP in agriculture has therefore resulted in the occurrence of residues and metabolites in food commodities (Darko G., Akoto O., 2008)

The current study monitors the levels OP pesticide residues in some vegetables crops collected from Egyptian local markets and compare the detected levels with the international established permissible limits MRL’s. Although this gives a good indication, it lacks the information necessary for a proper interpretation and in terms of food safety.

To evaluate the safety of consumers regarding pesticide residues, the exposure needs to be assessed and compared to health safety limits or toxicological endpoint values such as the ADI (acceptable daily intake) or the ARfD (acute reference dose). Whereas the MRL is a product limit and is based on the application of pesticides on crops according to Good Agricultural Practices (GAP) in controlled field experiments, health safety limits or toxicological endpoint values are based on toxicological data and insights. Exposure or intake of a compound below its health safety limit is considered to be safe. As such, the residue concentration may be above the MRL without representing a risk to the consumer (W.L. Claeys et al., 2011). In the present study, the daily intake of OP through the studies vegetables is evaluated in detail. Calculations are based on the results of the monitoring.

MATERIALS AND METHODS

Sampling

A total of 178 samples from eight vegetables, artichoke, cauliflower, cucumber, egg plant, green beans, pepper, squash and tomato were collected from seven Governorates, Cairo, Giza, Qualubiya, Ismailia, Fayium, Menofyia, Gharbyia in 2007. The number of samples analyzed for each vegetable and their scientific name is shown in table (1).

Two kilograms of each sample and 2 units of cauliflower were collected and prepared for residue analysis according to Codex Alimentariuos Commission, CAC (1993). Twenty nine OP pesticides either currently registered or banned in Egypt were subjected to analysis.

Samples preparation was performed according to the generally recommended method of sampling to achieve a representative part of the material to be analysed (Codex Alimentariuos Commission 1993).

Samples analyses were carried out either immediately upon their arrival to the laboratory or the samples were stored at 0-5 ^{o}C for no longer 2 days before analysis.

Pesticide Residues Analysis

The Official Method of AOAC, (AOAC International 1995) was followed with some modifications, the details of the procedure and the validation data described in (Dogheim et al, 2004). The multi-residue method allowed the determination of 29 organophosphorous pesticide residues.

GC determination

The detection and confirmation of pesticides residues in the samples was made using two chromatographic columns of different polarities equipped with nitrogen-phosphorus detectors (NPD) installed in one GC instrument with one injector. Quantitative determinations are made using ditalimfos as an internal standard.

Quality Assurance

The analytical method and instruments were fully validated as part of a laboratory quality assurance system and were accredited according to ISO/IEC 17025:2005 by FINAS (Center for Metrology and Accreditation) Finland. Codex quality assurance criteria were followed to determine the performance of the multi-residue method. The average percentage recoveries for the tested pesticides from different commodities ranged from 80-110% at spiking levels of 0.01 -0.1 mg/kg, with coefficients of variation (CV %) of 2.5-13%.

The reproducibility expressed as relative standard deviation was less than 20%. The limit of quantification ranged between 0.02-0.5 mg/kg. The measurement uncertainty including random and systematic error at 95% confidence level was estimated to be less than 10%. Blank samples were fortified with the pesticides mixture and analyzed as a normal sample with each set of samples. The results were recorded on control charts. Repeated analysis of old samples was regularly carried out to control reproducibility

Apparatus

(a) Gas chromatography: Hewlett Packard (HP) 5890 (USA) equipped with double Nitrogen Phosphorus Detector (NPD), injector 225 °C, detector 280 °C.

Operating conditions: - Hydrogen 3.5 ± 0.1 ml/min, Air 100-200 ml/min, and Nitrogen carrier gas 25 ml/min.

The information on chromatography columns was as follows:

- PAS-5 ECD tested ultra 2 silicon; 25 m x 0.32 mm film thickness 0.52 um.
- PAS -1701 ECD tested 1701 silicon; 25 m x 0.32 mm film thickness 0.25 um.

Temperature program of GC instrument was as follow: initial temperature 90 ^{o}C for 2 min; ramp (1) 20 (^{o}C min^{-1}) to 150 ^{o}C. ramp (2) 6 (^{o}C min^{-1}) to 270 ^{o}C held for 15 min.

Splitless injection mode was used with injection volume 1 ul.

Reagents

Solvents and chemicals

(a) Acetone, dichloromethane, n-hexane, petroleum ether, Pestiscan chromatography grade or similar quality.

(b) Anhydrous sodium sulphate (Riedel-de Haen), sodium chloride

Pesticides reference standards

Acephate, azinophos – ethyl, Azinophos –methyl, cadusafos, chlorpyrifos, chlorpyrifos-methyl, cyanophos, diazinon, dimethoate, ditalimfos, edifenphos, ethion, ethoprophos, fenitrothion, fenthion, malaoxon, malathion, methamidophos, monocrotophos, omethoate, parathion methyl, parathion-ethyl, phenthoate, pirimiphos-ethyl, pirimiphos-methyl, profenofos, prothiofos, pyrazophos, tolclofos-methyl, triazophos (30 pesticides, ditalimfos used as internal standard)

All reference materials are certified provided by Dr. Ehrenstorfer Gmbh, Gogginger Str. 78 D- 8900 Augoburg and are prepared in n-hexane/ acetone mixture.

RESULTS AND DISCUSSION

Monitoring results

A total of 178 samples of eight crops of mostly consumed vegetables; artichoke, cauliflower, cucumber, egg plant, green beans, pepper, squash and tomato were identified in table (1).

All samples were examined for residues of 29 organophosphorous pesticides as mentioned in the section on Pesticides Reference Standards.

According to the Agricultural Ministerial Decree No. 1835 at 2011 issued by pesticide committee that has been regulates the procedure of pesticides handling, Codex Alimentarius Maximum Residue Limits was followed as it available and in case of lack of pesticide/ commodity MRL, European or EPA (Environment Protection Agency, USA) limits were followed.

Artichoke, Cauliflower and Squash have no pesticides in all analysed samples; details of the residues detected, the mean, concentration range and the number of violated samples is given in table (1).

Overall, 87% of the vegetables samples had no detectable organophosphorus pesticides. Of the analysed samples, 13.5% contained detectable residues, of which 4.5% exceeded MRL's.

However, the rates of violations and contamination reported by the Food and Drug Adminstration FDA, for Pesticide Residues Monitoring Program 2007 demonstrated that 63.1% of vegetable samples are free of detectable pesticides residues, 34.1% contaminated with residues of which 2.8% exceeded MRL's.

Data reported by S.M. Dogheim et al, 2002 illustrated the percentages of free vegetables samples throughout 1995, 1996 and 1997 were 67.3 %, 81 % and 83.9 % respectively, that may reflect the effectiveness of steps taken by the competent authority to decrease the volume of pesticides use in Egypt. But on the other hand, the violation percentages increase at the current study than the previous data, the violation percentage of the vegetables samples at 1995, 1996 and 1997 were 1.2%, 1.9% and 1.8% respectively, that may due to lack of modern application techniques of pesticide spraying available for the farmers that cause deviation of the recommended dose and leads to higher residues than the permitted tolerance.

Data in table (1) showed, four out of 29 organophosphorus tested pesticides were detected in the studied vegetable samples. The frequencies and percentages of detected residues were as follow: chlorpyrifos detected in 12 samples with percentage 6.7 % followed by profenofos detected in 11 samples with percentage 6.2%, then ethion and chlorpyrifos-Me detected in 3 and 2 samples with percentages 1.7%, 1.1% respectively. Nonetheless, , levels of the OP residues measured in this survey were mostly lower than those reported in previous surveys (Dogheim et al., 1999, 2001, 2002 and 2004). The present study has revealed that chlorpyrifos was detected in cucumber, eggplant, green bean, pepper and tomato with mean values, 0.03, 0.06, 0.32, 0.04 and 0.45 respectively.

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These levels observed are below the MRL for cucumber, eggplant and pepper, and exceeded MRL in 2 Green bean samples and one tomato sample. Meanwhile**,** chlorpyrifos-Me was found in 2 tomato samples with mean value 0.13 mg/kg without violation of MRL. Profenofos was detected in eggplant, pepper and tomato with mean value 0.49, 0.31 and 0.42 mg /kg, respectively. Profenofos exceeded MRL only in two sample of eggplant. Results also showed that ethion was found in one pepper and 2 tomato samples, with mean values, 0.52 and 0.11 mg/kg respectively. All values detected in sample are exceeded MRL , MRL set at limit of quantification and it withdrawn from codex alimintariuos data base.

EPA has assessed the risks associated with the organophosphate (OP) pesticide ethion, the last legal use of ethion was in December 2004 and the tolerances for commodities have been cancelled, US, EPA fact sheet of Ethion.

The results ensure that organophosphorus pesticides are still the predominate pesticides used in Egypt, that may be due to wide spectrum of their efficacy and relative cheap price and the farmer become familiar with it.

Estimation of exposure

Pesticide residues intake can be estimating using different types of methods. The intake of pesticides has been estimated in many countries using permitted maximum residue levels. These TMDI (theoretical Maximim Daily Intake) or EMDI (Estimated Maximum Daily Intake) calculations have been overestimates. The intake estimation method used in this survey can be assigned under the codex system to the group Estimated Daily Intake (EDI) (Ladomery 1987, and Pirj-Lisa Penttila , Kalevi Siivinen, 1996).

Food consumption:

One of the major constraints of the present study was the meager information of food consumption in Egypt. Scanty available information would not take into consideration differences between individuals and their food consumption. The estimation of intake was made for the total population. The food consumption figure used were based on Egyptian food balance sheet issued by economic affairs sector, central administration for agricultural planning, ministry of agriculture, 2008 and also on the consumption data issued by GEMS/ Food regional diet, 2003.

GEMS/ food regional diet is a hypothetical diet prepared by GEMS/Food to represent a regional group of countries in which the quantitative intake of food commodities is similar based on data derived from FAO Food Balance Sheets. It was notes that some difference of consumption value between GEMS and Egyptian figures such as in tomato, cucumber and pepper.

Estimated daily Intake (EDI) calculation:

The intake of OP residues detected in vegetables samples has been evaluated by calculating the estimated daily intake (EDI) based on the monitoring results obtained and the consumption data set either by GEMS/food and Egyptian balance sheet. The obtained value compared with ADI (acceptable daily intake) set by FAO/WHO. The ADI of a chemical is the estimate of the amount of a substance in food or drinking-water, expressed on a body-weight basis that can be ingested daily over a lifetime without appreciable health risk to the consumer on the basis of all the known facts at the time of the evaluation (FAO/WHO; 1997). It is expressed in milligrams of the chemical per kilogram of body weight.

The estimated daily intake of a particular pesticide was calculated by multiplying the pesticide residue level in each commodity (mg/kg) by respective average food consumption (kg/day) and then summing the results. The average residue level of a pesticide in a commodity was calculated as the mean value of all samples. The estimated daily intake was calculated as follow:

$EDI= \sum F_i \times R_i \times P_i$

where:

F_i= average food consumption (g/person/day)

R_i = avarge residue level of food commodity (mg/kg);

P_i = correction factor for processing, the influence of processing was not estimated in this study

The percentage of EDI from ADI is obtained by dividing EDI by their corresponding values of WHO/FAO acceptable daily intakes, ADI (FAO/WHO). In order to compare these with the ADI, the total intake figures are divided by an assumed body weight of 60 kg, WHO, 1997.

Table 2 and 3 contains the average daily intake values of the OP residues and their corresponding percentages of ADI.

Data in table 2 illustrated the intake of the detected OP in the eight vegetable crops. Chlorpyrifos showed highest intake through tomato, 53.1 µg kg^{-1} day^{-1} , the intake of chlorpyrifos from cucumber, eggplant,and green beans were, 0.177, 0.738, 1.088 and 0.52 respectively

Also, chlorpyrifos-Me, ethion and profenfos intake in tomato showed the highest figures, thus the consumption of tomato could pose some health risks due to the levels of OP residue present in it when the intake value compared with ADI's of each pesticide, the current results in accordance in some extend with that of (Godfred D., Osei A , 2008) that indicates health risks were found to be associated with methyl-chlorpyrifos, ethyl-chlorpyrifos, and omethoate in tomatoes.

In general, the intakes of OP pesticides found in the vegetables under the current study were higher than the intakes calculated for OP in some vegetables from Ghana (Godfred D., Osei A , 2008)

However, the processing factors such as washing , peeling, cooking of vegetables reduce significantly the OP residues levels, but, many factors such as physical and chemical property of pesticide, the type of vegetable, processing procedure, application of pesticide, etc. would also have significant bearing on the removal of pesticide residues (Gouri S., *et al.,* 2011).

The results also showed that no apparent health hazard was found in association with the consumption of other analysed vegetables even with some violation and exceeding of MRL

Data in table (3) showed that, the intakes of OP pesticides were generally lower than 100% of the Acceptable Daily Intakes (ADIs).

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Based on the GEMS/food consumption rate, the highest intake was that of profenofos 59.62 ug/ person followed by chlorpyrifos 55.62 ug/person, chlorpyrifos-Me ,15.34 ug/person and then ethion 12.98 ug/person, these intake level significantly increased in case of calculation of intake based on Egyptian food consumption rate to be profenofos 110.41ug/ person followed by chlorpyrifos 109.4 ug/person, chlorpyrifos-Me 30.42 ug/person and then ethion 25.74 ug/person.

Table (3): The Estimated Average Daily Intake of Detected OP Pesticide Residues in Vegetables.

Pesticide	ADI ug/kg bw	Estimated average daily intake using GEMS consumption			Estimated average daily intake using Egyptian consumption		
		Intake ug/person	Intake* ug/kg bw	Percent of ADI	Intake ug/person	Intake* ug/kg bw	Percent of ADI
Chlorpyrifos	10	55.62	0.927	9.27	109.4	1.82	18.23
Chlorpyrifos-Me	10	15.34	0.256	2.56	30.42	0.51	5.07
Ethion	2	12.98	0.216	10.82	25.74	0.43	21.45
Profenofos	30	59.62	0.994	3.31	110.41	1.84	6.13

***The total intake figures are divided by an assumed body weight of 60 kg to compare with ADI**

- Percent of ADI= $\frac{\text{intake ug/kg bw}}{\text{ADI}} \times 100$

These increase due to high consumption rate recorded by Egypt food balance sheet than of GEMS/food that required amendments should submitted from Egypt to FAO/WHO

Data in table 3 also showed the highest percent of ADI was recorded for ethion which were 10.82% and 21.45% based on GEMS and Egypt food balance sheet respectively. This is probably because of lower ADI of ethion as it recommended to withdrawn from most of registrations pesticides system in most of countries.

The second highest percent of ADI was chlorpyrifos (9.27% and 18.23% of ADI) followed by profenofos (3.31 % and 6.13% of ADI) and then by chlorpyrifos-Me (2.56% and 5.07%) based on GEMS and Egypt food balance sheet respectively that indicate certain hazards to consumer initiated from OP which required expand of such kind of surveillance and continuous assessing of dietary exposure for different population categories, such as children, elderly, and other special groups

Conclusion:

Because pesticide residues in food constitute a significant health risk, their continuous monitoring and estimation of the hazard indices as well as the control in food items is of great importance. Additionally, the toxicological significance of consumer exposure to pesticides in the diet should addressed through an appropriate comparison of exposure estimates with toxicological endpoints such as the reference dose (RfD) or the acceptable daily intake (ADI). However comparison with MRL in not enough to evaluate the risk of pesticides on consumers

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تقدير المتناول من بقايا المبيدات الفسفوريه في بعض محاصيل الخضر من مصر، دراسه اوليه

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1-وزاره الزراعه ، مركز البحوث الزراعيه ، المعمل المركزي لتحليل متبقيات المبيدات والعناصر التقيله في الاغذيه ، الدقي ، جيزه ، مصر

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تم جمع 178 عينه من الخضروات الاكثر إستهلاكا من سبعه محافظات مصريه خلال عام 2007. إستخدمت طريقه تحليل تكشف عن العديد من المركبات وتم استخدام جهاز كرواتوجرافي الغاز. تم تحليل 29 مركب فسفوري بإستخدام طريقه معتمده بإستخدام جهازNPD.في المجمل تبين من الدراسه أن 87 % من عينات الخضر التي تم تحليلها خاليه من المركبات الفسفوريه تحت الدراسه، وأن 13.5% تحتوي علي متنبقيات المبيدات الفسفوريه منهم 4.5% تعدت الحدود القصوي المسموح بها.

أوضحت النتائج وجود 4 مبيدات من 29 مبيد فسفوري تحت الدراسه في عينات الخضر التي تم تحليلها.

وكانت التكرارات والنسب المئوية من بقايا المبيدات الفسفوريه كالتالي: مبيد كلوربيريفوس وجد في 12 عينه بنسبه مئويه 6.7% يليها مركب بروفينوفوس وجد في 11 عينه بنسبه 6.2% ثم وجد مركب الايثيون و الكلوربيريفوس ميثيل في 3 عينه و2 عينه علي التوالي بنسبه 1.7% لمبيد الايثيون ونسبه 1.1% .

تم إجراء تقييم المخاطر عن طريق حساب الاستهلاك اليومي المقدر (EDI) و مقارنته مع المتناول اليومي المسموح به (ADI). وبوجهه عام تبين ان المتناول المقدر من المركبات الفسفوريه اقل من 100% من المتناول اليومي المسموح به (ADI). اوضحت الدراسه ان المتناول من المبيدات الفسفوريه من الطماطم هو الاكثر. وقد وجد ان المتناول المحسوب لكلا من مبيد البروفينوفوس 59.62 ميكروجرام / للفرد ومن مبيد الكلوربيريفوس 55.62 ميكروجرام / للفرد ، الكلوربيريفوس ميثيل 15.34 ميكروجرام / للفرد ،الايثيون 12.98 ميكروجرام / للفرد وذلك بناء علي معدلات الاستهلاك المقرره من GEMS/food.

قام بتحكيم البحث

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Table (1): Minimum, maximum, mean (mg kg -1) as well as frequencies , number and percentages of contaminated samples , violated samples and detected pesticide residues in analyzed vegetables samples collected from the Egyptian local markets during 2007

Product	Total No.	Pesticide detected	Frequency	Range		Mean mg/kg	Free samples		Contaminated samples		MRL mg/kg	Violated samples	
				Min mg/kg	Max mg/kg		No.	%	No.	%		No.	%
Artichoke *Cynara cardunculus*	24	Not detected	-	-	-	-	24	100	-	-	**-**	-	-
Cauliflower *Brassica oleracea*	15	Not detected	-	-	-	-	15	100	-	-	**-**	-	-
Cucumber *Cucumis sativus*	24	Chlorpyrifos	2	0.03	0.03	0.03	22	92	2	8.3	**0.05 EU**	-	-
Egg plant Solanum melongena	24	Chlorpyrifos	2	0.03	0.09	0.06	21	88	3	12.5	**0.5 EU**	2	8.3
		Profenofos	2	0.09	0.89	0.49					**0.05 EU**		
Green beans *Phaseolus vulgaris*	22	Chlorpyrifos	2	0.29	0.35	0.32	20	91	2	9.1	**0.01**	2	9.1
Pepper *Piper nigrum*	24	Chlorpyrifos	3	0.03	0.06	0.04	17	71	7	29.2	**2**	1	4.2
		Ethion	1	0.52	0.52	0.52					**0.01 EU**		
		Profenofos	4	0.14	0.51	0.31					**5**		
Squach *Cucurbita pepo*	22	Not detected	-	-	-	-	22	100	-	-	**-**	-	-
Tomato *Lycopersicon esculentus*	23	Chlorpyrifos	3	0.07	1.2	0.45	13	57	10	43.5	**0.5**	3	13.0
		Chlorpyrifos-methyl	2	0.05	0.2	0.13					**1**		
		Ethion	2	0.04	0.17	0.11					**0.01 EU**		
		Profenofos	5	0.07	1.3	0.42					**10**		
Total No.	**178**						**154**	**87**	**24**	**13.5**		**8**	**4.5**

The scientific names of each vegetable mentioned below each common name

free sample = no residues detected under the analysis condition, contaminated samples= samples with detectable residues , residues detected at lower than LOQ not included, MRL, maximum residues limits established by codex Alimentarious, 2010, MRL of EU selected in case of codex limit absence

Table (2): Estimated Daily Intakes for each pesticide/ commodity based on food consumption of GEMS/food and Egyptian food balance sheet

Pesticide	Product	mean mg/kg	ADI* mg kg^{-1}bw day^{-1}	Reference	GEMS[1]		Egyptian[2]	
					C[3] kg/day	EDI µg kg^{-1} day^{-1}	C[4] kg/day	EDI µg kg^{-1} day^{-1}
Chlorpyrifos	Cucumber	0.03	0.01	FAO/WHO, 1999	0.0059	0.177	0.0219	0.657
	Egg plant	0.06			0.0123	0.738	**0.0123****	0.738
	Green beans	0.32			0.0034	1.088	0.006	1.92
	Pepper	0.04			0.013	0.52	0.0197	0.788
	Tomato	0.45			0.118	53.1	0.234	105.3
Chlorpyrifos-Me	Tomato	0.13	0.01	FAO /WHO 1992	0.118	15.34	0.234	30.42
Ethion	Tomato	0.11	0.002	FAO /WHO, 1990	0.118	12.98	0.234	25.74
Profenofos	Egg plant	0.49	0.03	FAO /WHO, 2011	0.0123	6.027	**0.0123****	6.027
	pepper	0.31			0.013	4.03	0.0197	6.107
	Tomato	0.42			0.118	49.56	0.234	98.28

*** ADI= Acceptable Daily Intake issued by WHO/FAO**
**** the consumption of egg plant taken from GEMS in both calculated EDI due to lack of Egyptian data**
1= consumption of GEMS regional food balance sheet was used in calculation of EDI, Estimated daily intake
2= Egyptian food balance sheet issued by economic affairs sector, central administration for agricultural planning, 2008 used in calculation 0f EDI
3= average consumption of each commodity set by GEMS/food
4= average consumption of each commodity set by Egyptian economic affairs sector
EDI (µg /kg /day) = mean of residues(mg/kg) × consumption of food (GEMS or Egyptian rate in kg/day) / 1000

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