Dietary Intake of Pesticides Based on Vegetable Consumption: A Case Study, Jeddah, Kingdom of Saudi Arabia

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Abstract: The aim of the present study was to monitor the residues of 42 pesticides in different vegetable samples (tomato, squash, cucumber, egg-plant, green pepper, and potato) collected from 5 major supermarkets located in Jeddah, Saudi Arabia. A multi residue method was carried out by gas chromatography with mass spectrometry (GC-MS). Residues of some organophosphorus insecticides such as malathion and profenofos, as well as some pyrethroid pesticides, such as fenpropathrin and cypermethrin, were found in a number of samples at concentration levels exceeding or equal to their Maximum Residues Levels (MRLs). Data obtained was then used for estimating the potential health risks associated with the exposures to these pesticides. The Estimated Daily Intake (EDI) has been estimated between 0.00015 and 0.20 mg/kg body weight/day and the hazard index (EDI/ADI) less than the unity for the tested compounds.

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1.Introduction

Fruits and vegetables are important components of the human diet since they provide essential nutrients that are required for most of the reactions occurring in the body. A high intake of fruits and vegetables (five or more servings per day) has been encouraged not only to prevent consequences due to vitamin deficiency but also to reduce the incidence of major diseases such as cancer, cardiovascular diseases and obesity. Like other crops, fruits and vegetables are attacked by pests and diseases during production and storage leading to damages that reduce the quality and the yield. Therefore, farmers around the world use different types of pesticides including insecticides, fungicides and herbicides against the possibility of a devastating crop loss from pests and diseases, as well as to increase agricultural productivity to provide an adequate food supply for the increasing world population. Over the past couple decades a rapid increase in the quantity and use of pesticides in the agricultural sector has been observed and this growth trend is expected to continue for the next decades due to several socio-economic and technological developments (Greish, *et al .,* 2011).

Unfortunately, many pesticides are toxic substances and persistent in character. The residue of pesticides in food receives worldwide attention. When seeking to rationalise pesticide use, both government and stakeholder (Council Directive, 1990) have tended to make the implicit assumption that any rationalisation is primarily an issue of decreasing the quantity of pesticides used, coupled with the banning of specific highly toxic substances (Freidberg, 2003; Pretty and Hine, 2005). Thus, pesticides with high toxicity to human are targeted for rationalisation, irrespective of the quantity used. Monitoring of pesticide residues in vegetables for evaluation of vegetable quality is a priority objective of pesticide research to avoid possible risks to human health. Food contamination monitoring programs in the Middle East countries have been carried out over several years by many investigators (Al-Saleh, and Echeverria-Quevedo, 1999; Osman *et al .,* 2010) and their results revealed the occurrence of different pesticides residues from different chemical groups. In Saudi Arabia, Al-Saleh, and Echeverria-Quevedo, 1999 found, triadimefon found in 50% of rice grain samples, while dimethoate and malathion were found in 40 and 18% of samples, respectively. In Egypt, undetectable concentration levels of organoclorine residues were found in cucumber, but other commodities contained some DDTs only (Dogheim *et al .,* 2004). All the residue values were below the maximum residue limits (MRLs). In Kuwait, the average daily intakes of pesticides were well below acceptable limits, but higher than those reported from developing countries (Sawaya *et al .,* 1999). On the other hand, fruits and vegetables collected from Bahrain were free of pesticides except for one sample of mint which contained pirimiphos-methyl (Musaiger *et al .,* 2008).

Several multi residue methods for determination of pesticides in crops using gas chromatography for separation of individual compounds, followed by detection with selective and sensitive detectors have been proposed (Andersson and Pälsheden,1991;

Specht *et al .,* 1995; Stan, 2000). Gas chromatographic methods with mass spectrometry (GC-MS) have been used successfully for the analysis of many volatile pesticides. These methods offer simultaneous quantitation and confirmation of a large number of pesticides, excellent separation efficiency, high speed of analysis, and the wide range of sensitive and selective detectors available. Unfortunately, negligible data are available on the contents of pesticide residues in vegetables that sold in local markets of the Jeddah region in Saudi Arabia.

Long-term exposure to pesticides is increasingly suspected of being linked to a broad spectrum of medical problems such as cancer, neurotoxic effects, reproductive health concerns and endocrine disruption, particularly for specific populations such as farmers and their children (Bailey *et al .,* 2011; Baldi *et al .,* 2011). Therefore, although plant protection products are subject to a rigorous safety evaluation, improving knowledge on the human health impact of environmental and dietary exposure to pesticides is still a priority. For the general population, dietary intake is considered to be a major potential route of exposure to most pesticides (Panuwet *et al .,* 2009; Cao *et al .,* 2011). International guidelines for predicting chronic dietary intake of pesticide residues are widely used in Europe (WHO, 1997). The indicators proposed are calculated by combining consumption and contamination data (e.g. results of national monitoring programs), most often under a deterministic approach with point values, i.e. main or percentiles. The guidelines recommend refining these deterministic estimates, when necessary, by probabilistic approaches such as empirical distribution estimates, i.e. "individual-based deterministic approach" (FAO/WHO, 2008; EFSA, 2010).

The present study was undertaken to monitor pesticide residues in vegetables collected from big supermarkets located in Jeddah region using GC-MS detection to provide background information on the levels of these residues in vegetables sold in this region. Besides of that, the study also determines the current level of exposure of the local population of the Jeddah region to hazardous pesticides by consuming pesticides-contaminated vegetables.

2.Material and Methods

Sample collection

Vegetable samples were collected between October and December 2012 from 5 major public markets located in Jeddah region in Saudi Arabia. The selected vegetables were tomato, squash, cucumber, egg-plant, green pepper, and potato. Six samples of each vegetable (the sample size of each commodity was about 2 kg) from each supermarket were collected from the upper, middle, and lower shelves to give representative samples that were transferred to the laboratory. The selection of these crops was based on their popularity and high consumption rates at all community levels.

Reagents

Pesticide standards were obtained from the Environmental Protection Agency (EPA, USA) with certified purities ranging from 95 to 99%. The tested use and chemical group of pesticides are listed in Table 1. Concentrations of standard solutions were corrected for the certified purity of the standards. Methanol, acetone and ethyl acetate (HPLC grades) were purchased from BDH Company, UK. Ultra-pure deionized water of 15 MU cm resistivity was obtained from a water purification system (PURELAB Option-R, ELGA, UK).

Extraction:

Pesticide residues were extracted from all samples using the method of **(**Kadenezki *et al.* 1992) with some modifications. Composite samples (2 kg) were chopped into small pieces using a sharp knife, and were mixed thoroughly. A sample of 200 g was blended to obtain a homogenous representative sample. A sub sample of 20 g was taken in a 250 ml flask for extraction using 75 ml ethyl acetate and 25 g anhydrous sodium sulphate. The mixture was shaken for 2 h and then ethyl acetate extract was filtered through a Whatman (No. 4) Filter paper, to be ready to clean up.

Clean up:

Pesticides extract was cleaned up to remove interfering substances co-extracted with pesticide residues. A chromatographic column plugged with glass wool at the bottom, was filled with 15 g florisil that had been activated at 200°C for 24 h. Florisil layer was topped with 3 g charcoal, and the column was washed with 40 ml ethyl acetate. Sample extract was quantitatively transferred to the top of the column and the column was eluated with 40 ml ethyl acetate. The eluate was collected in a 100 ml glass beaker and was concentrated using a gentle air stream to near dryness. The near dry extract was dissolved in 0.5 ml acetonitrile and then analyzed using gas chromatography (GC).

Gas chromatographic determination

The detection and quantification of pesticide residues in the samples were performed using Hewlett-Packard GC model 5890A equipped with electron capture detector (ECD) and nitrogen phosphorous detector (NPD). The (ECD) gas chromatography was as follows detector temperature 90 - 300 °C, injector temperature. Two different wide-bore capillary columns were used for the analysis, the first one was Hewlett Packard PAS-5, ECD tested ultra 2 silicone (25 m × 0.32 mmi.d, film thickness 0.52 μm), while the second column was Hewlett

Packard PAS-1701(ECD ested 1701 Silicone) (25 m × 0.32 mmi.d, film thickness 0.25 μm). The applied temperature programming was as follows: initial temperature, 90°C; hold for 2 min; increased to 150°C at 20 - 96 °C min-1; hold for 2 min; increase to 220 °C at 6 - 97 °C min-1; hold for 15 min. Flow rate of nitrogen was 2.5 ml/min carrier, 75–90 ml/min (carrier + make up).A nitrogen phosphorous detector (NPD) was adjusted as follows: detector A temperature was 280°C, detector B temperature 100 – 280 °C, injector temperature 101 - 225°C. Two different capillary columns were used for the analysis. The first one was PAS-5 (Cross linked 5% PH ME Silicone). Column ID: 0.32 mm, Film thickness: 0.25 μm, Column length: 30 m; the second one PAS - 1701 (ECD Tested 1701 Silicone) Column ID: 0.32 mm, Film thickness: 0.25 μm and Col105 umn length: 25 m. Hydrogen Flow rate was 3.5 + 0.1 ml/min, air flow rate was100–120 l/min. Carrier gas: nitrogen, col. head pressure 75 kPa Carrier gas + detector auxiliary gas 25 ml/min, septum purge 5 ml/min, split vent 70 ml/min, split less time: 0.7 min.

Quantification

A standard solution containing a number of pesticides dissolved in hexane was injected several times to ascertain the average retention time of each. Vegetable samples extracted were injected and their contents of pesticides were identified according to their retention times. Standard solution of each identified pesticide was prepared and injected to establish the relationship between peak areas and concentrations. Good linearity was obtained in the range of 100 folds. The concentrations of pesticides in the fruit extracts were determined using the external standard method.

Calibration curves

Stock solutions of the selected pesticides (1000 $mg.ml^{-1}$) and serial dilutions ranging from 0.01 to 10 $ng.ml^{-1}$ were prepared using acetone. Mixed compound calibration solutions in acetone were prepared with concentrations disregarding their GC sensitivities and were used as spiking solutions as well. Areas under the peak versus concentrations were plotted and fit by simple linear regression to obtain the equation for the standard curves for the tested pesticides. The amount of each pesticide in each sample was thus calculated based on the slope of the standard curve.

Estimated pesticide dietary intake calculation:

Pesticides Intake (mg/kg b.w/day) = {pesticides residue (mg/kg) × consumption (kg/day)} ÷ body weight (kg).

3.Results and Discussion

To protect consumers' health, many countries have established legal directives to control levels of pesticides in food, through MRLs (Council Directive, 2003; FAO/WHO, 2004). Data in Table 2 show MRLs of the selected pesticides in testing vegetables. The levels of pesticide residues in foodstuffs are generally legislated to minimize the exposure of consumer to harmful or unnecessary intakes of pesticides, to ensure the proper use of pesticides in terms of granted authorization and registration (application rates and pre-harvested intervals) and also to permit the free circulation of pesticide-treated products, as long as they comply with the fixed MRLs. Monitoring the residues of pesticides in some commodities collected from 5 major supermarkets located in Jeddah, Saudi Arabia was the main aim of this work. Therefore, controlling the pesticide levels seems to be a substantial contemporary public health problem to guarantee food quality and to evaluate the health risk. The levels, ranges, frequency and identity of pesticide residues found in the analyzed samples are outlined in Table 1. In the analyzed samples, residues of 42 pesticides with different physicochemical properties (28 insecticides, 8 fungicides, 5 herbicides and 1 acaricide) were detected.

In the present study, pesticide residues were determined in six vegetable crops, namely: tomato, cucumber, green pepper, eggplant, squash and potato. The selection of these crops was based on their popularity and high consumption rates at all community levels. Pesticide residue analysis results (Table 2) indicate that, all vegetable samples had some detectable pesticide residues with three to seven pesticides. Residue analysis in tomato samples indicated that, three organophosphorus insecticides (malathion, Carbaryl and Chlorfenapyr), two pyrethroid pesticides (fenpropathrin and L-Cyhalothrin), one fungicide (Metalaxyl) in addition one acaricide (Dicofol) were detected. The present study revealed that cypermethrin is the most frequently detected pesticides in cucumber, with residue limits ranging between (0.20 ± 0.02 mg/kg), followed by the metalaxyl, detected at range between 0.018 ± 0.01 mg/kg. The synthetic pyrethroid insecticides, L-cyhalothrin and chloropyrifos were also detected in cucumber samples at residue levels of 0.04 and 0.02 mg/kg. While, all pesticide residues detected in green pepper, eggplant and squash samples did not exceed the EU-MRLs. In potato samples the most frequently detected pesticide was Chloropyrifos (detected in 25% of the samples). In comparison with other pesticide-monitoring studies in Saudi Arabia, it was reported that, there were higher residue levels of malathion and profenofos in tomato samples collected from different locations in Saudi Arabia (Al-Saleh, and Echeverria-Quevedo, 1999).

Pesticide residues detected in this study are in agreement with the low residue levels reported

(Loutfy *et al.,* 2008) for vegetable samples from the same governorate. As has been mentioned previously (Dogheim *et al.,* 2002), this low contamination level might be attributed to the risk-management steps taken by the responsible authority to decrease the volume of pesticides used in the country and to increase the use of integrated pest-management (IPM) programs, biopesticides, and pesticide alternatives. From a potential health perspective, it is important to compare exposure estimates to establish toxicological criteria such as estimate daily intake (EDI). The results obtained were used to calculate EDI expressed as microgram pesticides per kilogram body weight per day (mg/kg b.w/day). The EDI is a realistic estimate of pesticide exposure that was calculated in agreement with the international guidelines (FAO, 2002; WHO, 1997), using the following equation: **EDI = Σ C X F/DXW**

Where C is the sum of the concentration of pesticide in each commodity (mg/kg), F is the mean annual intake of food per person, D is the number of days in a year (365) and W is the mean body weight (60 kg). The annual intake per person of tomato, squash, cucumber and egg-plant are 27.3, 4.5, 7.8 and 3 kg/year respectively, according to the Saudi Arabian Food Balance Sheets performed 2002 - 2004 (Ministry of Agriculture of Saudi Arabia, 2006). If data from food balance sheets are not available for a commodity, the consumption level for a similar food is used (WHO, 1997). If data on a similar food is unavailable, a default value of 0.10 g/day is assigned which is the lowest quantified value in the current GEM/Food diet. In case of green pepper, the annual intake per person is 0.0365 kg/year (0.10 g/day).

Table 3 compares the estimated contribution of vegetables consumed to the intake of these pesticides (EDI) with the acceptable daily intakes (ADIs) established by FAO / WHO organization (FAO/WHO, 2004) for all the detected pesticides in order to evaluate the toxicological significance of human exposure to these pesticide residues. The data illustrated that, the intakes were much lower than the ADIs and the exposure level to whole pesticide residues was below the level to produce health risk.

The EDIs have been estimated between 0.00015 and 0.249 mg/kg body weight/day, while the hazard indices (EDI/ADI) ranged from 0.0005 to 28.25% for the tested compounds (Table 4). Thus, lifetime consumption of these vegetables could not pose a health risk for the Jeddah population as the indices for all the residues were less than one (Darko and Akoto, 2008). However, the present study shows a high incidence rate of pesticide residues (mostly insecticides) in vegetables should be considered because most of the tested vegetables are used without cooking treatment and are used fresh in preparing salad dishes. Moreover, vegetable consumers could be exposed to more than one pesticide at the same time.

The contribution to ADI shows that, all the intakes of pesticide residues are still below the safe limits. However, it should be emphasized that pesticide dietary intakes estimated in this study considered only exposures from some vegetables and did not include other food products or the rest of the vegetables. As such, estimates are not considered as total dietary exposure to the pesticides, nor do we consider drinking water, residential, or occupational exposures. Therefore, it is an underestimation of the total exposure to pesticides. Additionally, the effect of pesticides on more vulnerable groups such as children and pregnant women could affect these calculations.

Carcinogenicity of Pesticides Detected in the Present Study

As described by the EPA's Classification System for Carcinogens, when assessing possible cancer risk posed by a pesticide, EPA considers how strongly carcinogenic the chemical is (its potency) and the potential for human exposure. The pesticides are evaluated not only to determine if they cause cancer in laboratory animals, but also as to their potential to cause human cancer. In this issue, Table 5 shows the carcinogenicity of pesticides detected in the present study as described by the EPA's classification system for carcinogens. As seen in Table 5, cypermethrin was classified as Group C (possible human carcinogen). This group is used for agents with limited evidence of carcinogenicity in animals in the absence of human data (U.S. EPA. 1989). Malathion and chlofenapyr pesticides were classified as suggestive evidence of carcinogenicity but not sufficient to assess human carcinogenic potential. This descriptor is used when the evidence from human or animal data is suggestive of carcinogenicity, which raises a concern for carcinogenic effects but is judged not sufficient for a conclusion as to human carcinogenic potential. Four pesticides were classified as Group E–evidence of non carcinogenicity for humans and this group is used for agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies (U.S. EPA. 1989). In addition, three pesticides (chloropyrifos, fanarimol, and fenpropathrin) were described unlikely to be carcinogenic to human, and this means that, the available data on these compounds are considered robust for deciding that there is no basis for human hazard concern (U.S. EPA. 2006).

Table 1:- Chemical group, use, molecular weight and retention times of the tested pesticides by GC-MS.

Pesticide	Use	MW	t_R (min)	Pesticides	Use	MW	tR (min)
Chlorfenapyr	A	407	3.22	Ethion	A	384	15.56
Heptenophos	A	250	4.33	Bioallethrin	A	302	15.86
Tolclofos-methyl	B	300	6.62	b-Endosulfan	A	406	15.88
Carbaryl	A	201	8.22	Diniconazole	B	326	16.25
Amitrole	C	84	8.46	Triazophos	A	313	16.6
Propoxur	A	209	8.66	Carbofuran	A	221	16.82
Ethiofencarb	A	225	9.3	Fenhexamid	B	302	17.2
Lindane	A	290	9.91	Endosulfan sulfate	A	422	17.39
Propyzamide	C	256	10.2	Fenpropathrin	A	349	17.64
Methiocarb	A	257	11.71	Lindane	A	288	17.71
Fenithrothion	A	277	11.83	Spinosad A[b]	A	731	18.41
Aldrin	A	364	12.05	Bifenthrin	A	423	18.61
Chlorthaldimethyl	C	303	12.29	Paraquat	C	256	18.76
Parathion	A	291	12.46	L- Cyhalothrin	A	449	20.60
Fenthion	A	278	12.67	Fenarimol	B	331	20.84
Captan	B	300	13.5	Tefluthrin	A	418	21.21
Methidathion	A	302	13.79	Metalaxyl	B	279	21.39
Folpet	B	296	13.89	*cis*-Permethrin	A	391	21.86
Dieldirn	A	378	14.51	Dicofol	D	368	22.18
Azobenzene	D	182	14.72	Chlorpyrifos	A	349	23.11
Profenofos	A	373	14.92	Biphenyl	B	154	24.93
Bromoxynil	C	275	15.76	Methoxychlor	A	344	25.12

A = Insecticide, B = Fungicide, C= Herbicide and D = Acaricide

Table (2). Levels (mg/kg), frequencies and concentration ranges of pesticide residues and maximum residue levels (MRL) found in tested vegetable samples.

Samples	Pesticide	Contaminatedsamples		Residue level mg/kg Mean (± SD)	EU- MRL	% EU- MRL
		No	%			
Tomato	Fenpropathrin	8	25	0.13 ± 0.01	0.01	130
	L- Cyhalothrin	12	37	0.06 ± 0.01	0.1	60
	Metalaxyl	7	22	0.48 ± 0.01	0.01	4800
	Carbaryl	10	33	0.061 ± 0.01	1	6.1
	Dicofol	5	16	0.045 ± 0.001	0.5	9
	Malathion	12	37	0.025 ± 0.01	0.5	5
	Chlorfenapyr	3	10	0.033 ± 0.01	0.1	33
Cucumber	L- Cyhalothrin	4	14	0. 04 ± 0.001	0.05	80
	Cypermethrin	4	14	0.20 ± 0.02	0.1	200
	Metalaxyl	8	25	0.18 ± 0.01	0.2	90
	Chloropyrifos	5	16	0.02 ± 0.002	0.05	400
Green pepper	Fenarimol	6	19	0.032 ± 0.002	0.5	6
	Profenofos	8	25	0.06 ± 0.003	0.05	120
	Chloropyrifos	5	16	0.02 ± 0.004	0.5	4
Potato	Profenofos	6	19	0.035 ± 0.003	0.05	7
	Chloropyrifos	8	25	0.023 0.003	0.2	11.5
	L- Cyhalothrin	5	15	0.05 ± 0.02	0.1	50
	Chloropyrifos –M	2	10	0.03 ± 0.01	0.05	60
Egg plant	Carbaryl	9	30	0.06 ± 0.002	1	6
	Dicofol	3	28	0.01 0.001	0.02	50
	Metalaxyl	5	15	0.05 ± 0.001	0.2	25
	Malathion	5	15	0.02 ± 0.001	0.5	4
	Chlorpyrifos	9	30	0.05 ± 0.001	0.05	100
	Carbofuran	8	25	0.07 ± 0.001	0.3	23.3
	Paraquat	3	10	0.06 ± 0.004	0.05	120
Squash	Carbaryl	6	20	0.05 ± 0.001	1	5
	Dicofol	5	16	0.50 ± 0.001	0.02	2500
	Metalaxyl	5	16	0.05 ± 0.002	0.2	250
	Malathion	9	30	0.2 ± 0.003	0.5	40
	Chlorpyrifos	3	10	0.05 ± 0.005	0.2	25
	Carbofuran	4	13	0.05 ± 0.01	0.05	100
	Methoxychlor	3	10	0.09 ± 0.01	0.01	900

Table 3: Acceptable daily intake (ADI in μg/kg body weight/day), percentage of ADI, and pesticide estimated daily intake based on vegetable consumption data in Jeddah, Saudi Arabia.

Pesticides	Dietary intake (µg/kg bw/day)[a]						Total (EDI (mg/kg body weight/day)
	Tomato	Cucumber	Sweet pepper	Potato	Egg plant	Squash	
Fenpropathrin	0.00015	ND[c]	ND	ND	ND	ND	0.0001517
L- Cyhalothrin	0.0700	0. 04	ND	0.05	ND	ND	0.16
Metalaxyl	0.5600	0.018	ND	ND	0.01	0.05	0.638
Carbaryl	0.07117	ND	ND	ND	ND	0.05	0.1212
Dicofol	0.0525	ND	ND	ND	0.01	0.5	0.5625
Malathion	0.0292	ND	ND	ND	0.02	0.2	0.2492
Chlorfenapyr	0.0385	ND	ND	ND	ND	ND	0.0385
Cypermethrin	ND	0.2	ND	ND	ND	ND	0.20
Chloropyrifos	ND	0.02	0.02	0.023	0.05	0.05	0.163
Fenarimol	ND	ND	0.032	ND	ND	ND	0.032
Profenofos	ND	ND	0.06	0.035	ND	ND	0.095
Carbofuran	ND	ND	ND	ND	0.07	0.05	0.12
Paraquat	ND	ND	ND	ND	0.06	ND	0.06
Chloropyrifos – M	ND	ND	ND	0.023	ND	ND	0.023
Methoxychlor	ND	ND	ND	ND	ND	0.09	0.09

[a] Data are expressed as mean ± S.D. Each value is the mean of 20 samples. ND[c] means not detected

Table (4):- Acceptable, estimated daily intakes and hazard index for pesticide residues found in the vegetables studied

Pesticides	ADI (µg/kg b.w/day) (source; year)	EDI (mg/kg body weight/day)	Hazard index (EDI/ADI, %)
Fenpropathrin	30 (JMPR; 2006)	0.000151667	0.000505557
L- Cyhalothrin	20 (JECFA; 2000)	0.16	0.8
Metalaxyl	30 (JECFA; 2006)	0.638	2.126666667
Carbaryl	3 (JMPR; 2006)	0.121166	4.038866667
Dicofol	2 (JMPR; 2006)	0.5625	28.125
Malathion	30 (JECFA; 2006)	0.249166	0.830553333
Chlorfenapyr	15(ECCO 1999)	0.0385	0.256666667
Cypermethrin	20 (JMPR; 2009)	0.20	1
Chloropyrifos	10 (JMPR; 2004)	0.163	1.63
Fenarimol	10 (JMPR; 1995)	0.032	0.32
Profenofos	30 (JMPR; 2007)	0.095	0.316666667
Carbofuran	2 (JMPR; 2006)	0.12	6
Paraquat	4 (JMPR; 2006)	0.06	1.5
Chloropyrifos –M	10 (JMPR; 2004)	0.023	0.23
Methoxychlor	100 (JMPR; 2006)	0.09	0.09

Table (5):- Carcinogenicity of pesticides as described by EPA's classification system for carcinogens. Supplementary Data.

Pesticide	Carcinogenicity
Fenpropathrin	Not likely to be carcinogenic to humans, this descriptor is used when the available data are considered robust for deciding that there is no basis for human hazard concern.
L-Cyhalothrin	Group D–Not classifiable as to human carcinogenicity. This group is generally used for agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.
Malathion	Suggestive Evidence of carcinogenicity but not Sufficient to Assess Human carcinogenic Potentialal. This descriptor is used when the evidence from human or animal data is suggestive of carcinogenicity, which raises a concern for carcinogenic effects but is judged not sufficient for a conclusion as to human carcinogenic potential.
Chlorfenapyr	Suggestive Evidence of carcinogenicity, but Not Sufficient to Assess Human carcinogenic Potential. This descriptor is used when the evidence from human or animal data is suggestive of carcinogenicity, which raises a concern for carcinogenic effects but is judged not sufficient for a conclusion as to human carcinogenic potential.
Profenofos	Group E–Evidence of Non carcinogenicity for humans. This group is used for agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.
Cypermethrin	Group C–Possible human carcinogen, this group is used for agents with limited evidence of carcinogenicity in animals in the absence of human data.
Metalaxyl	Group E–Evidence of non carcinogenicity for humans. This group is used for agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.
Chloropyrifos	Group E–Evidence of non carcinogenicity for humans. This group is used for agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.
Fenarimol	Not Likely to be carcinogenic to humans. This descriptor is used when the available data are considered robust for deciding that there is no basis for human hazard concern.
Chloropyrifos—M	Not Likely to be carcinogenic to humans. This descriptor is used when the available data are considered robust for deciding that there is no basis for human hazard concern.
Carbaryl	Likely to be carcinogenic to humans. Classified by the EPA as a likely human carcinogen and is toxic to the nervous system.
Dicofol	Not likely to be carcinogenic to humans. EPA has determined that there is limited evidence that dicofol may cause cancer in laboratory animals, but that there is no evidence that it causes cancer in humans.
Carbofuran	This substance/agent has not undergone a complete evaluation and determination under US EPA's IRIS program for evidence of human carcinogenic potential.
Paraquat	Paraquat's carcinogenic potential has not yet been thoroughly evaluated; however, the EPA has classified the pesticide as a possible human carcinogen.

Conclusions

Long term accumulation of pesticide residues in the human body via dietary intake of vegetables and other food commodities is a severe problem, as indiscriminate amounts of such pesticides are used in many countries. Moreover, controlling the pesticide levels seems to be a substantial contemporary public health problem to guarantee food quality and to evaluate the health risk. The present research was aimed to evaluate the possible health risk of pesticide residues via dietary intake of vegetables in Jeddah city, Saudi Arabia. The results of the present study highlighted the presence of pesticide residues in vegetables collected from local markets in Jeddah, Saudi Arabia; however the contamination level could not be considered a serious public health problem. The routine of monitoring these pollutants in food items is required to prevent, control, and reduce the contamination to minimize health risks.

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