Evaluation and Risk Assessment of Pesticide Residues in Egyptian Tomatoes

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Abstract: Food contamination by pesticides is a great concern everywhere, a multiresidue method was evaluated for the quantitation of several pesticides by gas chromatography/mass spectrometry. The Quick Esay Cheap Effective Ragged and Safe (QuEChERS) method was used for pesticides extraction. The pesticides have been separated using capillary column gas chromatography, and the electron impact mode of mass spectrometry was used for identification. The majority of pesticides recoveries from the tomato were more than 80%. Precision and linearity met expectations. The calculated limits of detection and quantification, respectively, fell within the ranges of 0.01 to 0.1 mg/kg and 0.05 to 0.5 mg/kg. Proposed pesticide multiresidue analysis technique was useful and able to applied in routine food contamination monitoring programs.

Keywords: Pesticides; tomato; QuEChERS; gas chromatography/mass spectrometry.

1.Introduction:

The Egyptian economy mainly depends on the agricultural sector. Egypt has a population of more than113 million people (**Kemp, 2023)** and 3.97 million hectares (**Galal, 2022).**

About 20% of gross domestic products, all exports, and 34% of all jobs are in the agricultural sector (**Tchounwou *et al.,* 2002**). During production and storage, pests and pathogens attack fruits and vegetables, causing damage that lowers their quality and yield. In agricultural practice around the world, more than 800 pesticides from over 100 different chemical families are often utilized (**Tomlin, 2003**).

Chemicals identified as pesticides are frequently employed in current agricultural practices to protect crops from various diseases and pests **(Guler *et al.,* 2010)**. One of the main inputs used for increasing crop yield in agriculture is pesticides **(Bajwa and Sandhu, 2014)**. Pesticides play an important role in agricultural development because they can reduce the losses of agricultural products and pest damage on crops to improve return and food quality at reasonable prices (**Tudi *et al.,* 2021**; **Song *et al.,* 2020; He *et al.,* 2015; Thelin and Stone, 2013** and **El-Hefny, 2008)**.

Pesticide residues in fruits after harvest are frequently caused by the use of pesticides during production. Pesticide residues in vegetables and fruits are considered impact issue in Egypt **(Ahmed *et al.,* 2014)**. Pesticide residues must be estimated after the application on crops, fruits and vegetables to determine the waiting period between the application and harvesting to ensure that the waste is less than allowed levels and became safe and valid for human consumption (**Sallam, 1998**).

Due to its direct impact on human health, food safety is a topic of growing concern on a global scale, and the majority of countries have established or adopted Maximum Residue Levels (MRLs) for pesticides in food in order to protect human health. Consumers are very concerned about the existence of dangerous pesticide residues in food. The World Health Organization (WHO) reports that 20% of pesticide use in the world is concentrated in developing countries posing a danger to human health and the environment (**Hurtig *et al.,* 2003 and Afari-Sefa *et al.,* 2015**).

Fruits and vegetables are a particularly rich source of carbs, fats, vitamins, minerals, antioxidants, and other crucial nutrients; they are necessary for a balanced and healthy diet. As part of a healthy diet overall, eating a diet high in fruits and vegetables may lower your chance for developing numerous diseases. (**Gad Alla *et al.*, 2015**)

China, the USA, India, Turkey, Egypt, Italy, Iran, Spain, Brazil, and Mexico were the top tomato producers, accounting for 75% of global production **(Mohamed *et al.*, 2018)**. The tomato is one of the most significant and widely cultivated vegetable crops in Egypt. Egypt is the fifth-largest tomato producer in the world, producing 9 million tonesof tomatoes annually **(Shalaby, 2016)**. Tomato is used in large quantities to produce soup, juice ketchup, puree, paste and powder **(Shiboob, 2012)**.

The QuEChERS method used is a more straightforward extraction method, and a typical process for analyzing pesticide residues entails extraction from food commodities, cleaning of co-extracted materials, and then confirmation was done using gas chromatography (GC) combined with mass spectrometry (GC-MS) based on electron impact (EI) ionization mass spectra. This method has historically been used to analyses of multiple pesticide residues in food (**Soler, 2007**).

The present study investigated the determination of the pesticide residues in tomatoes and studied the impact of some processing processes (washing, peeling, and cooking) on the remaining pesticides.

2.Material and methods:

2.1. REAGENTS

Certified reference standards were purchased from Dr. Ehrenstorfer GmbH (Augsburg, Germany). The purities of these standards were ≥ 98%.

Organic solvent acetonitrile and methanol (HPLC grade) were purchased from Merck (Darmstadt, F.R. Germany). QuEChERS salts (4 g $MgSO_4$, 1 g NaCl, 1 g trisodium citrate dihydrate, 0.5 g disodium hydrogencitrate sesquihydrate), and d-SPE salts were purchased from Agilent Technologies (Wilmington, DE, USA). Bulk primary secondary amine (PSA) sorbent (Bondesil-PSA, 40 µm) was bought from Supelco.

A Milli-Q Gradient System (Millipore Corporation, Billerica, MA, USA) was used to produce ultra-purified deionized water (DI).

Stock standard solutions of pesticides (1000 g/ml) were prepared in acetonitrile. Working standard solutions were prepared by serially dilution of the working solutions and dilution and mixing of the stock standard solutions. Calibration standard mixtures of concentration levels 0.01, 0.05, 0.1, 0.5, 1, 2.5 and 5 µg/ml were prepared in acetonitrile. The stock standard solutions were stored in amber bottles at −18ºC and the working solution were kept in the refrigerator at 4 ºC.

2.2. SAMPLING

A total of 51 samples of tomato fresh fruits were collected October 2021. All samples were randomly collected from different markets (Tema, Jehaina, almaragha, Sagulta, Akhmim, Shandaweel and Sheikh Makram) in Sohag Governorate. The collected samples consisted of (1-2) kg and were sealed in sterile polyethylene bags. The samples were serially numbered after collection and were located in an ice box before immediate transference to the pesticide residue laboratory. Samples are prepared for subsampling and then stored at – 20 °C in a deep freezer until analysis. All samples were tested within 14 days after collection.

2.3. Effect of the house processing on tomato fruits

The collected samples were divided into three equal parts (500g each). The first was subjected to washing for three minutes with running tap water and then left to dry on clean paper for 30 minutes at room temperature to study the effect of washing on loss of the tested pesticides. The second part was analyzed without being washed. The third part was cooked for 30 minutes without adding anything.

2.4. Samples Preparation

The extraction and clean -up processes were carried out at the Water and Environment Laboratory in the Regional Center for the Development of Southern Upper Egypt - Quraman Island – Sohag. The tested samples were

prepared with the QuEChERS method according to **(Anastassiades *et al.*, 2003).** Ten grams of homogenized tomatoes samples were weighed into a 50 ml PTFE centrifuge tube, 10 mL of acetonitrile were added, the tube was vigorously hand shaken for 1 min, 4 g of anhydrous $MgSO_4$, 1 g of sodium chloride, 1 g trisodium citrate dihydrate and 0.5 g disodium hydrogencitrate sesquihydrate were added, the tube was hand shaken for 30 s., and the mixture was centrifuged at ≤4000 rpm for 5 min. An aliquot of 1.0 mL of acetonitrile phase was transferred into the d-SPE 2.0 ml centrifuge tube containing 25 mg PSA and 150 mg $MgSO_4$. The tubes were well capped and vortexed for 30 s., then centrifuged for 5 min at ≤4000 rpm. The combined eluate was filtered through a 0.22-µm nylon syringe filter into an auto sampler vial for injection.

2.5. Gas chromatography/mass spectrometry

Gas chromatography equipped with an Agilent Technologies 6890 detector was used. An Agilent 7673 auto-sampler and split/splitless capillary injection port were installed on the gas chromatograph. An HP-5 MS, 30 m 0.25 mm I.D. (5%-phenyl)-methylpolysiloxane capillary column from (Agilent Technologies) with 0.25 m thickness film was used for chromatographic separation. The oven temperature schedule included 100 ºC for two minutes, 10 ºC /min to 220 ºC for two minutes, 10 ºC /min to 260 ºC for two minutes, and 10 ºC /min to 280 ºC for ten minutes. The flow rate of helium (the carrier gas), which is 99.999% pure, was 1.5 mL/min in constant flow mode. At 300 ºC, a split-less injection of 1 μL of volume was performed, with a transfer line temperature of 230 ºC and in SIM mode, the mass spectrometer was run in electron ionisation mode. The Software used was Chemstation (Agilent TechnologiesTM), which provided data analysis assurance.

2.6. Validation

The suitability of the method was appropriately validated prior to its application in real samples in order to ensure that the found results were reliable.

Pesticide-free tomatoes samples were used for all validation methods. The lowest concentration that produces a reaction that is 3 times the baseline average was identified as the detection limit (LOD). The smallest amount of a certain pesticide that produces a response that is 10 times the average of baseline was identified as the limit of quantitation (LOQ). Standard solutions produced in both blank matrix extract and pure solvent were used to study the linearity of the response. The range of concentrations under investigation was 0.01 to 5 mg/kg. For tomato matrix, recovery experiments were conducted at three concentration levels (0.05, 0.5, and 5 mg/kg). Tomato samples were extracted and analysed on the same day; the repeatability was evaluated. For each sample, there were three assays run. For three days, spiked samples at three concentration levels were examined daily to determine repeatability.

2.7. Risk Assessment

By comparing the observed residue concentrations to the prescribed acceptable daily intake (ADI), risk assessment is calculated. The arithmetic mean of all the values obtained was used to assess the level of residue concentration in tomato. To avoid overestimating the estimated daily intake (EDI), residues larger than the Limit of Quantification (LOQ) were employed in the exposure calculation. Assuming an average adult body weight of 60 kg, the EDI (mg kg^{-1} bw^{-1} day) of each pesticide residue was computed by multiplying the mean concentration of pesticide residue (mg kg^{1}) by the food intake rate (kg day^{1}) and dividing by body weight **(WHO, 2020)**. The following formula was used to determine the estimated daily intake (EDI) of pesticide residues.

$$EDI = \sum RLi \times {}^{Fi}/_{Bw}$$

$$RQ = {}^{EDI}/_{ADI}$$

RLi = residue level of the vegetable;

Fi = food consumption data;

BW= Body weight.

RQ= risk quotient

In order to determine the risk quotient (RQ), the EDI and ADI are divided. For the consumer, a risk with an RQ value lower than 1 is acceptable, whereas a risk with a value higher than 1 is not acceptable.

3. Results and discussion:

3.1. Optimization of chromatographic analysis

To achieve the optimal separation-resolution compromise of the various groups of the investigated pesticides in the shortest amount of time, numerous tests were conducted. Table (1) displays the retention time (Rt) and primary characteristic m/z for the 47 pesticides.

3.2. Validation of method

Table (1): RETENTION TIME, QUALITATION AND QUANTITATION.

No.	Pesticides	Rt	Qualitative ion (m/z)	Quantitative ion (m/z)
1	**Acetamprid**	13.1	56, 126, 152	56
2	**Azoxystrobin**	18.8	77, 198, 105	77
3	**Boscalid**	12.5	140, 112, 243	140
4	**Buprofezin**	10.8	105, 172, 305	105
5	**Captan**	9.2	79, 149, 107	79
6	**Chlorpyrifos**	8.3	97, 197, 314	197
7	**Clethodim**	19.1	164, 205, 178	164
8	**Chlorfenapyer**	19.9	59, 60, 247	59
9	**Chlorothalonil**	13.1	266, 264, 268	266
10	**Clodinafop-propargyl**	16.6	349, 266, 238	349
11	**Cypermethrin**	22.5	163, 165, 181	163
12	**Cyproconazole**	18.9	222, 139, 224	222
13	**Cyprodinil**	16.1	225, 224, 210	225
14	**Deltamethrin**	24.5	181, 253, 281	253
15	**Diazinon**	4.9	179, 137, 152	179
16	**Difenoconazole**	23.9	265, 323, 267	265
17	**Dimthoate**	5.8	87, 93, 125	87
18	**Epoxyconazole**	17.0	192, 138, 194	192
19	**Fluazifop-p-butyl**	13.4	282, 254, 383	282
20	**Fludioxonil**	21.0	248, 127, 154	248
21	**Fusilazole**	11.4	233, 206, 234	233
22	**Indoxacarb**	20.6	203, 59, 150	203
23	**Lambda cyhalothrin**	19.9	181, 197, 208	181
24	**Malathion**	9.4	125, 173, 99	125
25	**Methomyl**	21.2	58, 88, 105	105
26	**Metalaxyl**	7.3	206, 132, 160	206
27	**Metribuzin**	10.5	198, 144, 182	198
28	**Myclobutanil**	14.3	179, 152, 181	179
29	**Omethoate**	10.9	156, 110, 79	156
30	**Oxadiazon**	15.6	175, 177	175
31	**Oxyfluorfen**	15.5	252, 361, 300	252
32	**Penconazole**	9.1	159, 248, 161	159
33	**Pendimethalin**	13.7	252, 161, 281	252
34	**Pirimicarb**	7.1	72, 166, 238	166
35	**Pirimiphos methyl**	8.2	290, 276, 305	290
36	**Profenofos**	14.1	337, 339,97	337
37	**Propiconazole**	16.2	69, 173, 259	69
38	**Pyraclostrobin**	25.8	132, 164, 111	132
39	**Pymetrozine**	12.3	98, 113, 112	98
40	**Pyriproxyfen**	19.9	136, 77, 78	136
41	**Quizalofop-P-ethyl**	21.2	299, 372, 163	299
42	**Spirodiclofen**	17.9	71, 99,157	71
43	**Spiromesifen**	22.8	57, 272, 99	57
44	**Tebuconazole**	16.5	125, 70, 250	125
45	**Thiobencarb**	10.5	72, 100, 125	100
46	**Triazofos**	14.8	161, 77, 97	161
47	**Triticonazole**	18.3	235, 83, 115	235

Limits of quantification and detection ranged from 0.05 to 0.5 mg/kg and 0.01 to 0.1 mg/kg, respectively. All used pesticide were detected in limits lower than the MRL which accepted for the commodity. With the use of a standard solution prepared with both blank matrix extract and pure solvent, the linearity of the response was investigated. Integrated peak area data were used to construct the curves. The linear relationships for the pesticides in blank matrix extract and pure solvent are R ≥0.98. The precision of the method was verified by repetitive analysis. The method provided suitable repeatability and reproducibility for most compounds in the tomato matrix. The recoveries of extraction procedure were studied by spiking tomato matrix studied (n = 5). The average recoveries were determined for each pesticide matrix combination. Recoveries ranged between 81.29±2.22 to 106.37±1.99 and relative standard deviation (RSD) ≥12.5%. In conclusion, the recovery values obtained for tested pesticides for tomato commodity were within the acceptance criterion of 80–110% with a precision RSD of ≥20% (**SANTE/12682/2019**), meaning the method performed well.

3.3. Application to real samples

About 51 tomato samples were gathered from several markets in the Sohag Governorate in 2021. These markets included Tema, Jehaina, almaragha, Sagulta, Akhmim, Jehaina, Shandail, and Sheikh Makram. Regarding 47 pesticide residues that are often used in Sohag governorate. Table 2 lists the pesticides that are found more frequently.

Data gathered indicated that the majority of tomato samples are pesticide free samples. On the other hand, fifteen pesticides, including (Acetamprid, azoxystrobin, boscalid, chlorpyrifos, chlorfenapyr, cypermethrin, dimethoate, indoxacarb, methomyl, omethoate, pirimicarb, pymetrozine, quizalofop-P-ethyl, and spirodiclofen), were discovered in tomato samples.

Data in Table (2) showed that out of 51 tomato samples there were 4 (7.84%) contaminated with Acetamoprid and chlorfenapyr, 8 (15.68%) contaminated with azoxystrobin, 9 (17.67 %) contaminated with chlorpyrifos, 10 (19.60 %) contaminated with difenoconazole, 3 (5.88 %) contaminated with pirimicarb and 2 (3.92 %) contaminated with boscalid, dimethoate, indoxacarb, methomyl, omethoate, pymetrozine, quizalofop-p-ethyl and spirodiclofen.

The number of tomato samples with residue levels above MRL was also demonstrated by data in Table 2. For acetamiprid, 3 out of 4 samples were positive, compared to 1 out of 2 for boscalid, omethoate, and quizalofop-p-ethyl. Chlorfenapyr had 2 samples out of 4, difenoconazole had 2 out of 10, and pirimicarb had 2 out of 3 samples. On the other hand, the Codex and European MRLvalues were exceeded in all tomato samples that were contaminated with Acetamprid, omethoate, Pirimicarb pymetrozine, dimethoate, and chlorpyrifos. While all contaminated tomato samples with azoxystrobin, cypermethrin, indoxacarb, methomyl and spirodiclofen did not exceed the Codex and European MRL values.

Similar findings were also reported by **Mutengwe *et al.*, (2016)** who found that, on average, 32.2% of the 199 different fruits and vegetable samples tested positive for at least one of the pesticides in the domestic fresh produce markets in South Africa. According to data from **(Dogheim *et al.*, 2001**), 23.9% of 1,579 samples collected from eight fresh vegetable markets in Egypt had detectable pesticides. (**Lee *et al.*, 1998**) stated that there were detectable pesticides in 36.2% of 126 samples from seven fresh fruit markets in Mauritius, while (**Kneževié and Serdar, 2009**) found that there were detectable pesticides in 25.8% of 240 samples from Croatia. Based on 350 samples from six fresh vegetable markets, (43.5%) were recorded contaminated with pesticides in Ghana (**Bempah *et al.*, 2011**).

Our results also agreed with those of **Gad Alla *et al.*, (2013)** who reported that the residues of azoxystrobin, dimethoate and omethoate were (0.1, 0.34 and 0.1 mg/kg, respectively). **Ibrahim *et al.*, (2022)** observed the residues of azoxystrobin, chlorpyrifos, cypermethrin, difenoconazole, indoxacarb, methomyl, omethoate and spirodiclofen were (0.007, 0.048, 0.057, 0.035, 0.018, 0.008, 0.018 and 0.021 mg/kg, respectively). **Saleh *et al.*, (2020)** reported that the residues of azoxystrobin, boscalid, chlorpyrifos, cypermethrin, dimethoate, indoxacarb and methomyl were 0.01, 0.015, 0.01, 0.28, 0.01, 0.025 and

0.05 mg/kg, respectively. Also, (**Abdelkader *et al.*, 2021**) assured in on tomato the azoxystrobin, chlorfenapyr, cypermethrin, dimethoate, difenoconazole residues were (0.13, 0.1, 0.033, 0.01 and 0.015 mg/kg), respectively.

Table (2): The range of detected pesticides, mean in mg/kg, the number of contaminated and the MRL exceeding samples in samples collected during 2021.

No.	Pesticides	Range mg/kg	Mean mg/kg	Contaminated samples of tomato commodity		No. of sample exceeded MRL	MRL Mg/kg
				No.	%		
1.	**Acetamprid**	0.21-0.70	0.53	4	7.84	3	0.5 EU
2.	**Azoxystrobin**	0.15-2.22	0.95	8	15.68	0	3 EU
3.	**Boscalid**	0.39-3.11	1.75	2	3.92	1	3 EU
4.	**Chlorpyrifos**	0.05-0.93	0.29	9	17.67	9	0.01 EU
5.	**Chlorfenapyr**	0.02-0.66	0.34	4	7.84	2	0.4 Codex
6.	**Cypermethrin**	0.09-0.09	0.09	1	1.96	0	0.2 Codex
7.	**Difenoconazole**	0.29-2.31	1.06	10	19.60	2	2 EU
8.	**Dimthoate**	0.02-0.06	0.04	2	3.92	2	0.01 EU
9.	**Indoxacarb**	0.22-0.42	0.32	2	3.92	0	0.5 Codex
10.	**Methomyl**	0.28-0.94	0.61	2	3.92	0	1 Codex
11.	**Omethoate**	0.01-0.03	0.02	2	3.92	1	0.01 EU
12.	**Pirimicarb**	0.23-0.78	0.54	3	5.88	2	0.5 EU
13.	**Pymetrozine**	0.01-0.35	0.18	2	3.92	2	0.02 EU
14.	**Quizalofop-P-ethyl**	0.01-0.08	0.04	2	3.92	1	0.05 EU
15.	**Spirodiclofen**	0.11-0.42	0.26	2	3.92	0	0.5 Codex

3.4. The effect of different processes (washing, peeling and cooking) to remove pesticide residues

The findings of this investigation showed that pesticide residues were most prevalent in tomatoes and that they mostly accumulated on the crops' exterior surfaces. The dissolution, which is connected to the pesticide residue's water solubility, is the most significant mechanism that could result in the potential residue change during home washing processes. Additionally, the penetration is a dynamic process that could influence how a pesticide residue behaves when being washed. Table 3 displayed how washing affected the elimination of pesticide traces from tomato sample. No residues were found in any tomato puree; however, most tomato samples had less residues, with removal rates ranging from 56 to 100%.

Pesticides must be used to control pests in crops, especially in fruit and vegetable crops. The handling, storage, and processing that take place after the harvest of raw agricultural products have the most influence on the level of pesticide residues in food. If great agricultural and good industrial practices are strictly followed, the amount of pesticide residues would be decreased to below the relevant maximum residue level. Therefore, it is safe to eat raw or cooked fruit and vegetables. Customers therefore prepare household items before usage to reduce any potential risks. But can these remedies really get rid of pesticide residues. According to a review of the extensive literature, additional processing techniques including peeling, soaking in chemical baths, and blanching can reduce pesticide residues more effectively than washing and soaking, which often only yields a modest decrease. In general, how residual behavior varies after processing can be explained by the physicochemical properties of the pesticide and the type of the process. The significant impact of kitchen procedures like washing, peeling, and cooking techniques on residue minimization (**Aktar *et al.*, 2010 and Vemuri *et al.*, 2014)**. Data revealed that almost no detectable pesticide residues were present in any tomato paste or peeled cucumber samples. For instance, it is crucial to assess the decrease of residues using straightforward washing processes and the amount of residue still present on tomatoes in the peel and pulp (**Andrade *et al.*, 2015**). In another study, residue

reductions of 12–22% were observed after washing the fruits. In cucumber sample samples, washing with water decreased 24% of residues, and peeling eradicated 85% of residues. The reduction was considerably higher 79-87% after peeling the fruits (**Paradjikovic *et al.*, 2004**). Additionally, a water wash removed 51% of the procymidone residues from peaches used in a trial for infant food (**Balinova *et al.*, 2006**). The surface residues can be removed with washing procedures, whereas systemic residues found in tissues won't be significantly impacted. Thermal processing, such as cooking or sterilization, also has a wide range of effects depending on time, temperature, moisture loss, and whether the system is open or closed (**Holland *et al.*, 1994**).

A variety of variables such as volatility, solubility, formulation, and mode and site of application can affect how much pesticide (parent substance or metabolites) is detected in fruits and vegetables (**Cabras *et al.*, 1989**). Temperature, precipitation (and humidity), and air movement are extra environmental elements, have an impact on the durability of insecticides. The characteristics of the treated surface, the species of the treated surface, the type of harvested crop, the structure of the cuticle, the stage and rate of growth, and the general health of the plant are other factors in addition to the correlation between the weight of the treated surface and the living state of the plant surface.

Table (3): The effect of the different processes (washing and cooking) to remove pesticide residues from tomato sample.

No.	Pesticides	Unwashed mg/kg	Washed mg/kg	Removed %	Cooking mg/kg
1	Acetamiprid	0.70	0.21	71%	ND
		0.65	ND	100%	ND
		0.56	ND	100%	ND
2	Azoxystrobin	2.22	0.98	56%	ND
		1.69	0.63	63%	ND
		0.86	0.38	56%	ND
		0.68	ND	100%	ND
3	Boscalid	0.15	ND	100%	ND
		3.11	0.39	87%	ND
		0.55	0.09	84%	ND
4	Chlorpyrifos	0.93	0.12	87%	ND
		0.45	0.06	87%	ND
		0.11	ND	100%	ND
5	Chlorfenapyr	0.32	0.05	84%	ND
		0.66	0.13	80%	ND
		0.56	0.02	96%	ND
6	Cypermethrin	0.09	ND	100%	ND
7	Difenoconazole	2.31	0.97	58%	ND
		2.03	0.77	62%	ND
		1.66	0.59	64%	ND
		1.19	0.47	61%	ND
8	Dimthoate	0.33	ND	100%	ND
		0.29	ND	100%	ND
		0.06	ND	100%	ND
		0.02	ND	100%	ND
9	Indoxacarb	0.42	ND	100%	ND
		0.22	ND	100%	ND
10	Methomyl	0.94	0.28	70%	ND
11	Omethoate	0.01	ND	100%	ND
		0.03	ND	100%	ND
12	Pirimicarb	0.78	ND	100%	ND
		0.61	ND	100%	ND

		0.23	ND	100%	ND
13	**Pymetrozine**	0.35	0.01	97%	ND
14	**Quizalofop-P-ethyl**	0.08	0.01	88%	ND
15	**Spirodiclofen**	0.42	ND	100%	ND
		0.11	ND	100%	ND

ND = not detected

3.5. Dietary exposure and dietary risk assessment

The pesticides used for the assessment of dietary consumption and chronic risk were those that were most commonly found in tomato sample analysis, as shown in Table 4. Using residue information from the monitoring data, the average amounts of pesticide residues were computed. In an exposure evaluation, the EDI calculation's outcomes are presented separately for each pesticide. A chronic consumer risk can be excluded if the ADI for any commodity was not exceeded. The findings in table (4) demonstrate that the ingestion of pesticide residues never exceeds the ADI except for boscalid, difenoconazole and dimethoate pesticides. The risk quotient ranges from 0.12 of the ADI for quizalofop -p ethyl to 2.92 of ADI for difenoconazole. Previous data on risk evaluation of pesticide residues in investigated tomatoes show that, with the exception of some samples contaminated with boscalid, difenoconazole and dimethoate, there is no risk associated with consuming these types of tomatoes.

These results align with **Gad Alla *et al.*, (2015**) and **Ibrahim *et al.*, (2018)**. The present findings demonstrated that there is no link between Egyptian consumers' long-term exposure to pesticide residues from eating raw vegetables and health risks. It should be distinguished that the current study is restricted to a select few vegetables. Moreover, rather than assessing the increasing exposure to several pesticide residues in crops, the predicted risk assessment via long-term exposure is based on toxicological evaluation of the individual chemicals.

Three key steps in the process estimating pesticide residue levels, estimating food consumption patterns, and characterizing risk based on a comparison of exposure estimates with toxicological criteria have been described in the process of dietary pesticide risk assessment. There is a great deal of uncertainty around each step of the process, which could jeopardize the accuracy of the ultimate risk assessment. Common methods for calculating pesticide residue levels range from highly theoretical models that assume all residues are present at a predetermined level (usually at the tolerance level) to using market basket survey data collected at the time the product is ready for consumption.

Table (4): Acceptable daily intake of the most frequently detected pesticide residues and the risk quotient in tomato sample

Pesticides	Mean mg/kg	food consumption g/day	EDI mg/kg.bw /day	ADI mg/kg bw	Risk quotient
Acetamiprid	0.53	16.5	1.46E-04	0.07	0.21
Azoxystrobin	0.95	16.5	2.61E-04	0.2	0.13
Boscalid	1.75	16.5	4.81E-04	0.04	1.20
Chlorpyrifos	0.29	16.5	7.98E-05	0.01	0.80
Chlorfenapyr	0.34	16.5	9.35E-05	0.03	0.31
Cypermethrin	0.09	16.5	2.48E-05	0.02	0.12
Difenoconazole	1.06	16.5	2.92E-04	0.01	2.92
Dimthoate	0.04	16.5	1.10E-05	0.001	1.10
Indoxacarb	0.32	16.5	8.80E-05	0.01	0.88
Methomyl	0.61	16.5	1.68E-04	0.02	0.84
Omethoate	0.02	16.5	5.50E-06	0.001	0.55
Pirimicarb	0.54	16.5	1.49E-04	0.02	0.74
Pymetrozine	0.18	16.5	4.95E-05	0.03	0.17
Quizalofop-P-ethyl	0.04	16.5	1.10E-05	0.009	0.12
Spirodiclofen	0.26	16.5	7.15E-05	0.01	0.72

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تقدير وتقييم مخاطر متبقيات المبيدات في الطماطم المصرية

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الملخص العربى:

تم استخدام وتقييم طريقة كويتشر (تقدير المتبقيات المتعددة) في فصل العديد من المبيدات الحشرية تمهيدا لتقديرها كميا ونوعيا باستخدام كروماتوجرافيا الغاز/ الطيف الكتلي، حيث قد تم فصل المبيدات الحشرية بواسطة كروماتوجرافيا غاز العمود الشعري واكتشفها مقياس الطيف الكتلي في وضع تأثير الإلكترون. كانت نسبة الاسترجاع لغالبية المبيدات من الطماطم أعلي من 80 ٪، حيث تعتبر هذه النسبة الخطية والدقة مرضية. تراوحت الحدود المقدرة للكشف وحدود القياس الكمي من 0.01 إلى 0.1 ملجم/كجم ومن 0.05 إلى 0.5 ملج/كج، على التوالي. وقد تمت دراسة تأثير العمليات المنزلية (قبل الغسيل، بعد الغسيل، الطبخ) في إزالة متبقيات المبيدات وخفض نسبتها عند الإستخدام. حيث أظهرت العمليات المنزلية أن لها تأثير كبير فى خفض حدود متبقيات المبيدات من واقع النتائج الموضحة. تم العثور على الإجراء المقترح ليكون مفيدًا لتحليل المتبقيات المتعددة للمبيدات الحشرية في المنتجات الزراعية لبرامج المراقبة الروتينية.

الكلمات المفتاحية :المبيدات – الطماطم – كويتشر – الكروماتوجرافي الغازي / مطياف الكتلة