

## Pollution Status of Pesticide Residues in Food Products in Iran: A Mini-review within 2008-2018

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### A-R-T-I-C-L-E-I-N-F-O

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### A-B-S-T-R-A-C-T

**Background & Aims of the Study:** Pesticides are widely used in the agricultural sector to control pests. Based on numerous studies, the presence of pesticide residues in food causes a wide array of diseases. The current study aimed to identify pesticide residues in foods of vegetal and animal origin and presented the methods used to reduce pesticide content in food before consumption.

**Materials and Methods:** For the purpose of the study, the articles published within 2008-2018 were searched in the local and international databases, including PubMed, Science Direct, Scopus, using the keywords of pesticides, food, Iran, and residual, in both Persian and English languages. The current study focused on pesticide residues in foods of vegetal and animal origin. Furthermore, this study discusses the methods used to reduce residual pesticide before consumption. The preliminary search yielded 185 articles. After reviewing the articles, 26 studies were finally selected considering the purpose of the study.

**Results:** As evidenced by the obtained results, diazinon pesticide residue has been reported in many products. Pesticide residues were more frequently found in foods of vegetable origin, compared to those of animal origin. Effective factors influencing the presence of pesticide residues in food products include: farmers' unawareness, incorrect use of pesticide and inappropriate spraying, and disregard for the preharvest interval. Proper washing and immersion in alkaline solutions at a suitable time should be considered to decrease pesticide residues in food products before consumption.

**Conclusion:** The consumption of food products containing pesticides is associated with a variety of risks to humans, including nervous system dysfunction, reproductive disorders, brain damage, mental illness, and respiratory system disorder. The impact of pesticide residues can be minimized by training and awareness of farmers, Proper washing food products before consumption and as well as the supervision of executive organizations are the keys to the reduction of pesticide application in foods.

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## Background

Fruit and vegetables hold a special place in the daily diet of all people. Pesticides consist of a vast abundance of chemicals that are used to prevent, defeat, and decrease pests in different stages of fruit and vegetable cultivation (1, 2). To date, at least 1,000 active pesticide components have been registered in the world. They are available in different formulations provided by manufacturers (3). Numerous varieties of pesticides, including insecticides, herbicides, disinfectants, and fungicides, are employed for pest control.

Pesticides are assigned to different groups, namely organochlorine, organophosphate, carbamate, and pyruvate (4). Despite the exceptional economic and agricultural advantages of pesticides, they give serious cause for concern due to their possible harmful effects on human health (5). Many of these pesticides and their metabolites have been associated with several diseases, such as cancer, nervous system dysfunction, brain damage, mental illness, tumor, respiratory system disorder, asthma, Parkinson's disease, reproduction birth defects, and skin disease (6).

Their lipophilicity and persistence are the features that lead to the bioaccumulation of these compounds in adipose tissues and organs of biological species. In addition, biomagnification occurs throughout the food chain and food web as a result of the high rate of contamination in top predators (7).

Although human exposure to pesticides happens via various routes, the consumption of food products containing pesticides is the main pathway. Most pesticide residues are found in food owing to the direct use of pesticides in agricultural commodities or during storage (8).

Nowadays, the use of pesticides is indispensable across the globe due to the storage of food. Therefore, many countries and

international organizations have introduced several regulations for food safety and the sustainability of human health. Consequently, a monitoring system is necessary for the determination of human vulnerability to pesticides and the examination of pesticide residues in food. The present study was conducted on the pesticide contamination of food products in Iran.

## Materials & Methods

For the purpose of the study, the articles published within 2008-2018 were searched in the local and international databases, including PubMed, Science Direct, Scopes, using the keywords of pesticides, food, Iran, and residual, in both Persian and English languages. The current study focused on pesticide residues in foods of vegetal and animal origin. Furthermore, the methods used to reduce residual pesticide before consumption were presented in this article. The preliminary search yielded 185 articles. After reviewing the articles, 26 studies were finally selected considering the purpose of the study. It is noteworthy that retrieved articles were classified according to the origin of food. In addition, the pesticide residues identified in studies were compared with accepted maximum residue limits (MRLs) as adopted by the FAO/WHO Codex Alimentarius Commission (9).

## Results

Based on the findings, various studies have been carried out to determine the contamination of residual pesticides in different vegetal, animal, and grain products (Table1, 2, and 3). Most pesticides have been used for pest control in plant-derived products. They are often used to attack fungal and insect-derived diseases. The pesticide residues have been evaluated in

**Table 1) Summary of pesticide residues in food with vegetal origin products in different parts of Iran**

Food	Pesticide	Type of Pesticide	N	Contamination rate	city	reference
Thompson Orange	Diazinon	Organophosphorus	100	0.00175 to 0.01153 mg/kg	Sari	(25)
Greenhouse Cucumbr	Ethion	Organophosphorus	90	1.31- 1.63 mg/kg	Hamadan	(12)
Shrub and Nonshrub Cucumbers	Benomyl Mancozeb	Carbamate	76	0.0346 ppm 0.035 ppm	Mazandaran	(26)
Greenhouses Cucumber	Mancozeb Carbaryl	Carbamate	69	1.903 + 0.021 mg/kg 1.802 + 0.026 mg/kg	Tehran	(27)
Tomato and Cucumber	Dizanon	Organophosphorus	90	BDL to 0.38 mg/kg BDL to 0.12 mg/kg	Kermansha h	(15)
Tomatoe	Diazinon Oxydemeton-methyl	Organophosphorus		0.276 mg/ kg 1.624 mg /kg	Kerman	(11)
Tomatoe	Dichlorvs	Organophosphorus		6.20 mg/kg	Hamadan	(13)
Cucumber	Diazinon Malation	Organophosphorus	132	Max= 0.018±0.0033 mg/kg Min =0.009± 0.0011 mg/kg	Mazandaran	(14)
Cucumber	Lindane	Organochlorine	20	2.74 ±0.30 mg/kg	Mazandaran	(28)
Apple	Abamectn Diazinon chlorpyrifos	Organophosphorus	50	ND 0.0032–0.0624 mg/kg 0.0054–0.0553 mg/kg	Mahabad	(29)

**Table 2) Summary of pesticide residues food of animal origin products in different parts of Iran**

Food	Pesticide	Type of Pesticide	N	Contamination rate	city	reference
Fish	dichlorodiphenyltrichloroethane (DDT) hexachlorocyclohexanes (HCHs) hexachlorobenzene (HCB)	Organochlorine	95	330±335 ng/g 170±00 ng/g 34±40 ng/g	Shadegan Marshes	(30)
Fish (Liza aurata and Rutilus frisii kutum)	Total organochlrine	Organochlorine	6	2.1-9.03ng/g	Mazandaran	(18)
Fish (Rutilus kutum, Rutilus caspicus, Clupeonella cultriventris and Mugilidae)	Lindane	Organochlorine	244	7.8-43.23ng/g	Mazandaran	(31)

Table 1 Continued.

<b>Fish (Rutilus Frisii Kutum, Cyprinus Carpio, Leaping Mullet)</b>	Diazinon	Organophosphorus	27	29.04±25.02ng/g	Mazandaran	(32)
<b>Fish</b>	Lindane	Organochlorine	173	7.570-49.570 ng/g	Mazandaran	(28)
<b>Fish (Carp)</b>	Total Organochlorine	Organochlorine	360	133.624± 81.32 ng/g 180.59 ±259.01ng/g 91.23±37.75 ng/g	Susan Gerd Mahshahr Shadegan	(17)
<b>Seafood</b>	DDTs	Organochlorine	36	176.36±320.78 ng/g	Southern of Iran	(33)
<b>Pasteurized milk</b>	Dieldrin DDE DDD DDT HCB HCH	organochlorine	54	0.01 ng/ g 2.21 ng/ g 2.81 ng/ g 6.83 ng/ g 9.43 ng/ g 6.09 ng/ g	Tehran And Mazandaran	(34)

Table 3) Summary of pesticide residues in food products with grains origin in different parts of Iran

Food	Pesticide	Type of Pesticide	N	Contamination rate	city	reference
<b>Tea (Domestic and Imported)</b>	Endosulfan sulfat and Bifenthrin	Organochlorine pyrethroid	53	<LOQ to 20 µg/kg <LOQ to 35µg/kg	Tehran	(35)
<b>Wheat</b>	Atrazine Amytrin	Organophosphorus	32	0.1 µg/kg 0.299 µg/kg	Ahvaz	(36)
<b>Sugar</b>	Atrazine Amytrine	Organophosphorus	30	0.1921 µg/kg 0.5559 µg/kg	Ahvaz	(37)
<b>Sugar Beet</b>	chlorpyrifos			35 µg /kg	Isfahan	(23)
<b>Rice</b>	Diazinon chlorpyrifos	Organophosphorus	24	0.0036 to 0.0057 µg /kg 0.0124 to 0.0126 µg /kg	Amol	(22)
<b>Tea( Iranian tea and imported tea)</b>	Propineb	Dithiocarbamate	14	1.60±0.27 µg/kg 0.78±0.63 µg/kg	Hamadan	(38)
<b>Rice</b>	Multi-Class Pesticides*			767 to 1.110 µg / kg	Tehran	(39)
<b>wheat</b>	Deltamet rin Permethrin Malathion		36	23.5–73.6 µg /kg 10.7–74. µg /kg 25.5–167.4 µg /kg	Kermanshah	(24)
<b>olive oils</b>	2,4 DDT DDD Pretilachlr heptachlor		37	12 to 20 µg /kg < LOQ 9 to 46 µg /kg 9 to 27 µg /kg	Tehran	(40)

\* Azinphos-ethyl, Bromacil, Carbofuran, Chlorbromuron, Chlorfenvinphos, Coumaphos, Dialifos, Dcrotophos, Etrimfos, Fluometuron, Fuberidazole, Iprobenfos, Methabenzthiazuron, Methidathion, Monocrotophos, Omethoate, Phosphamidon, Phoxim, Propoxur, Pyrazophos, and TCMTB, Tri-allate

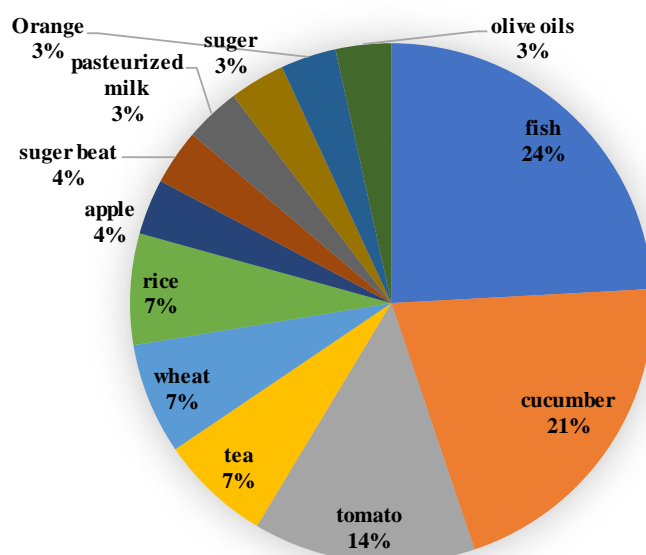


Figure 1) Pesticides residues in various food products in Iran

various food products, including rice, cucumber, tomatoes, wheat, and various types of tea and fish. The majority of studies have been conducted on products of vegetal origin. Compared to these products, the studies on pesticide contents of animal food products have been conducted on marine food products, especially fish species (Figure 1).

## Discussion

### *Pesticides residues in foods of vegetal origin*

Pesticides are used to produce more and higher-quality fruit and vegetables. Despite the benefits of pesticides, pesticide residues in fruits and vegetables can adversely affect consumer health (35). The safety of food plants of the family Cucurbits, such as cucumbers and tomatoes, for pesticide residues, has been widely examined. Furthermore, in the studies reported in this review, products of vegetal origin have been more assessed for the organo-phosphoric pesticide group, such as Diazinon, Ethion, and Mancozeb (Table 1).

The study of Diazinon residues in tomatoes grown in greenhouses (10) demonstrated that

the mean of Diazinon residues was 5.52 times the national Maximum Residue Limit (MRL=0.05 mg/kg). Moreover, the mean of oxydemeton methyl was calculated at 1.624 mg/kg which was 1.624 times the MRL (mg/kg) (9). Values reported from pesticide residuals showed that the level of pesticides in greenhouse tomatoes was high and significant. Furthermore, it was indicated that farmers use pesticides excessively without the supervision of related organizations.

A related study examined the Ethion insecticide residues in greenhouse cucumber and the efficacy of some processes in its reduction before consumption (11). The results denoted that the maximum and minimum Ethion residues after one-hour spraying were 1.63 and 1.31 mg/kg, respectively. Furthermore, it was added that storage for 24 h and washing (2 min) reduced the initial amount of pesticide residues by 43.2% and 52.7%, respectively. It was also argued that the implementation of some simple measures, such as storage, simple washing and optimization of dosage, number of sprays, and taking time to pick up after spraying, helps to reduce the residue of

pesticides before selling.

In another study, Nazemi et al. (12) studied the effect of storage and washing with various detergents on Dichlorvos residues in tomato. They found that Dichlorvos residue of the samples was below MRL during storage at room temperature and refrigerator after 8 and 10 days, respectively. Furthermore, they stated that soaking in water for 30 min, a solution of sodium chloride, acetic acid, and sodium bicarbonate decreased 35.75%, 34.62%, 14.48%, and 92.74% of Dichlorvos residue levels, respectively.

In another study carried out by Shokrzadeh et al. (13), the levels of Diazinon and Malathion residues in all cucumber samples were lower than 0.05. Nonetheless, the residue levels of Malathion were higher in some samples. Their results demonstrated that farmers' unawareness plays a peculiar role in pesticide application, along with easy access.

Another research was performed by Ghayebzadeh et al. on the pesticide residues in tomatoes and cucumbers in the markets (14). The results of the mentioned study reported that contamination values in three sampling areas of A, B and, D were 2(22.2%), 1(11.1%), and 2(22.2%), respectively. Diazinon level in cucumber specimens was higher than MRL in one region, while it was less than MRL in another area. In their study, the presence of pesticides residues was contributed to the following reasons:

- a: farmers' unawareness
- b: incorrect use of pesticide and inappropriate spraying
- c: disregard for the time interval between spraying and harvesting time.

### ***Pesticides residues in foods of animal origin***

Pollutants from contaminated supplies and water, and/or from pesticide application in animal production fields can accumulate on breeding animals. Pesticide mixtures are mostly stored in the fat and tissue of animals (36).

Different pesticides have been analyzed for detecting residues in food products of animal origin in Iran (Table 2).

The amount of pesticide residues has been extensively studied in fish species. Nearly all studies have reported contamination in samples throughout the country. Though the use of organochlorine pesticides is banned in the country, researchers have traced them in environmental samples. Arzi et al. (16) investigated concentrations of hexachlorocyclohexane isomers ( $\beta, \gamma, \delta$  HCH), dichlorodiphenyltrichloroethane (pp $\bar{o}$ , pp DDD) and its metabolites (ppDDE, ppDDD), Aldrin, Dieldrin, heptachlor epoxide, endosulfan isomers ( $\alpha, \beta$ ), and Methoxychlor in Carp fish assemblage. They observed 14 organochlorine pesticides in all collected fish samples. The maximum and minimum concentrations of organochlorine pesticides were related to  $\beta$ -HCH (65.36  $\mu\text{g/kg}$ ) and op DDT (0.13 $\mu\text{g/kg}$ ) observed in Mahshahr and Shadegan Carp fish, respectively.

In a similar vein, Manavi et al. examined organochlorine pesticide residues in two fish species of the southern Caspian Sea (17). The results showed that total organochlorine residues varied from 2.102 ppb-9.033 ppb in *Liza aurata* fish in the research area. They showed that in *L. Aurata*, Lindane pesticide displayed the greatest level among the evaluated components (1.642 ppb), whereas  $\alpha$ -Lindane designated the highest mean level of the measured components (0.57 ppb). The mentioned research demonstrated that the total amount of organochlorine compounds in *Rutilus frisii kutum* fish was greater than that in *L. aurata*. Nevertheless, no significant difference was observed between these two kinds of fish regarding pesticide residues ( $P > 0.05$ ). Fish feed contamination can be a potential source of direct entry and accumulation of pesticides in fish tissues (37). Based on previous studies, organophosphorus pesticides are used more frequently, compared to organochlorines (Table .2).



Several studies have examined the presence of pesticide residues in biological samples. These studies indicated that pesticide residues exist in food products and can enter the body through the food chain. Behrooz et al. investigated the hair and milk of Iranian pregnant women with organochlorine pesticide contaminants (38). They examined organochlorine pesticides, such as DDT and its metabolites, Hexachlorobenzene (HCB), a-, b-, and c-hexachlorocyclohexane (HCH), and seven Polychlorinated biphenyls (PCBs). Their finding showed that c-HCH isomer concentrations mean was higher, compared to the b-HCH isomer which is generally the most prevalent HCH in biological matrices. Moreover, they denoted that the samples which were taken from the hair of women in the countryside of Nowshahr, Mazandaran, Iran had the highest concentration of p,p-DDT ( 24 ng/g) with lower p,p0-DDE/p,p0-DDT ratio (0.6 ng/g) which suggest recent exposure to fresh DDT in this region. Their results pointed to a marked difference ( $P < 0.05$ ) in organochlorine containing HCHs between women who consumed fish once a week and those who used fish more frequently.

### ***Pesticides residues foods of grain origin***

In grains cultivation stages, pesticides are used during the growth of the vegetative plant to protect them against the harmful effects of insects, pests, pathogens, and, weeds. Furthermore, pesticides, especially insecticides, are applied during the storage time in order to avoid product loss. Although the use of pesticides increases the quality and production of beans, the presence of residual pesticides may adversely affect consumer health in the long run. Plant protection products can be applied at the stage of primary production, as well as during crop storage (39).

In their study, Shokrzadeh et al. (31) assessed organophosphorus insecticide residues, including Diazinon and Chlorpyrifos,

in Tarom and Persian rice samples (Table 3). The experimental results showed that almost all samples contained the residual Diazinon and Chlorpyrifos insecticides. They also reported that compared to previous studies, there has been a marked increase in the mean residual Diazinon insecticide in rice samples. Furthermore, they indicate that pesticide residue quantity was correlated with the time of insecticide application and harvesting. Along the same lines, Jalalizand et al. examined the amount of Chlorpyrifos pesticide residues in sugar beet (30). In this investigation, Chlorpyrifos residues were examined in sugar beets in the towns of Isfahan province in Iran. The result of the mentioned study indicated that the pesticide residues in sugar beets were higher than the maximum permissible residues (0.01 mg/kg sugar) in all study areas. It was noted that a short time interval between harvesting and consumption could result in high levels of pesticide residues higher than acceptable levels. It has also been stated that the provision of training and awareness to farmers regarding pests control by executive agencies can reduce pesticide applications. In another study, pesticide residues, including Deltamethrin, Permethrin, and Malathion, were assessed in stored wheat samples in soil (40). The results showed that the levels of Permethrin exceeded permitted levels in 3 out of 36 wheat grain samples.

Based on the insight gained from the above-mentioned studies, residual pesticides have been observed in most cereal products. Among the pesticides, Chlorpyrifos is a commonly utilized insecticide for pest control in grains all over Iran. Moreover, as evidenced by studies, a short time interval between spraying and harvesting is an effective factor influencing the amount of pesticide residue. Moreover, training and awareness of farmers, as well as the supervision of executive organizations are the keys to the reduction of pesticide application in foods.

## Conclusion

The presence of pesticides in food products is recognized as one of the most important risk factors for non-communicable diseases. The current review article aimed to identify pesticide residues in foods of vegetal and animal origin and presented the methods used to reduce pesticide content in food before consumption.

In addition, it sought to shed light on the causes of pesticide overuse in Iran. Diazinon has been studied in many types of research and the residual has been reported in many products. Proper washing and immersion in alkaline solutions at a suitable time should be considered to decrease pesticide residues in food products before consumption. Effective factors influencing the presence of pesticide residues in food products included: farmers' unawareness, incorrect use of pesticide and inappropriate spraying, disregard for the preharvest interval (PHI). therefore, due to the excessive intake of this pesticide, it requires the special attention of responsible organizations.

## Footnotes

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### Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of the current article.

## References

1. Akhlaghi H, Motavalizadehkakhky A, Emamiyan R. Determination of diazinon in fruits from northeast of Iran using the QuEChERS sample preparation method and GC/MS. *Asian J Chem* 2013;25(3):1727. [Link](#)
2. Picó Y, Blasco C, Font G. Environmental and food applications of LC–tandem mass spectrometry in pesticide-residue analysis: an overview. *Mass Spectrom Rev* 2004;23(1):45-85. [PMID: 14625892](#)
3. Jeyaratnam J. Acute pesticide poisoning: a major global health problem. *World Health Stat Q* 1990;43(3):139-44. [PMID: 2238694](#)
4. Morteza Z, Mousavi SB, Baghestani MA, Aitio A. An assessment of agricultural pesticide use in Iran, 2012-2014. *J Environ Health Sci Eng* 2017;15(1):10. [PMID: 28451437](#)
5. Bhandari G, Zomer P, Atreya K, Mol HG, Yang X, Geissen V. Pesticide residues in Nepalese vegetables and potential health risks. *Environ Res* 2019;172:511-21. [PMID: 30852454](#)
6. Wan N, Lin G. Parkinson's disease and pesticides exposure: new findings from a comprehensive study in Nebraska, USA. *J Rural Health* 2016;32(3):303-13. [PMID: 26515233](#)
7. Hardell S, Tilander H, Welfinger-Smith G, Burger J, Carpenter DO. Levels of polychlorinated biphenyls (PCBs) and three organochlorine pesticides in fish from the Aleutian Islands of Alaska. *PloS One* 2010;5(8):e12396. [PMID: 20811633](#)
8. Merten C, Ferrari P, Bakker M, Boss A, Hearty A, Leclercq C, et al. Methodological characteristics of the national dietary surveys carried out in the European Union as included in the European Food Safety Authority (EFSA) Comprehensive European Food Consumption Database. *Food Addit Contam Part A Chem Anal Control Expo Risk Assess* 2011;28(8):975-95. [PMID: 21732710](#)
9. Codex Alimentarius Commission, Joint FAO/WHO codex alimentarius commission, joint FAO/WHO food standards programme. *Codex alimentarius*. Mitchellville, Maryland: Bernan Associates; 2001. [Link](#)
10. Mohammed S, Lamoree M, Ansa-Asare OD, de Boer J. Review of the analysis of insecticide residues and their levels in different matrices in Ghana. *Ecotoxicol Environ Saf* 2019;171:361-72. [PMID: 30616153](#)
11. Ganjeizadeh RF, Mahdavi V, Aminaei MM. Evaluation of diazinon and oxydemeton-methyl residues by GC/NPD in tomatoes grown in Kerman Greenhouses. *J Agric Sci Technol* 2017;19:113-20. [Link](#)
12. Pirmoghani A, Shokoohi R, Samadi M, Leili M, Roshanaei G. Residue levels of ethion insecticide in greenhouse cucumber and its reduction using different procedures: a case study of Hamadan, 2015. *J Mazandaran Univ Med Sci* 2016;25(133):310-4. [Link](#)
13. Nazemi F, Khodadadi I, Heshmati A. Effect of



- storage type and time and washing methods on dichlorvos residues in tomato. *J Mazandaran Univ Med Sci* 2016;26(141):36-44. [Link](#)
14. Shokrzadeh M, Enayati A, Mokarami H, Ziar A. Assessment of diazinon and malation residues in cucumber produced in Mazandaran, Iran. *J Mazandaran Univ Med Sci* 2017;27(152):143-52. [Link](#)
  15. Ghayebzadeh M, Karimyan K, Gharagozlou F, Ghaffari H, Sharafi K, Sharafi H. Determination of diazinon pesticide residue in tomato and cucumber introduced in Kermanshah market by high performance liquid chromatography (2015). *Int J Pharm Technol* 2016;8(2):12874-80. [Link](#)
  16. LeDoux M. Analytical methods applied to the determination of pesticide residues in foods of animal origin. A review of the past two decades. *J Chromatogr A* 2011;1218(8):1021-36. [PMID: 21236435](#)
  17. Arzi A, Hemmati A, Nazari KZ. Determination and comparison of the organochlorine pesticide residue levels among benni fish of Shadegan, Mahshahr and Susangerd cities, Khuzestan Province in Iran. *Jundishapur J Natural Pharm Prod* 2011;6(1):24-31. [Link](#)
  18. Manavi PN, Mahdavi ES, Mazumder A. Organochlorine pesticides in two fish species from the southern Caspian Sea. *Mar Pollut Bull* 2018; 133:289-93. [PMID: 30041316](#)
  19. Nardelli V, Palermo C, Centonze D. Rapid multiresidue extraction method of organochlorinated pesticides from fish feed. *J Chromatogr A*. 2004; 1034(1-2):33-40. [PMID: 15116912](#)
  20. Behrooz RD, Barghi M, Bahramifar N, Esmaili-Sari A. Organochlorine contaminants in the hair of Iranian pregnant women. *Chemosphere* 2012;86(3):235-41. [PMID: 22047617](#)
  21. Lozowicka B, Kaczynski P, Paritova A, Kuzembekova G, Abzhaliyeva A, Sarsembayeva N, et al. Pesticide residues in grain from Kazakhstan and potential health risks associated with exposure to detected pesticides. *Food Chem Toxicol* 2014; 64:238-48. [PMID: 24316210](#)
  22. Shokrzadeh M, Karami M, Ghadi MA. Measuring organophosphorus insecticide residue in rice produced in Amol, North of Iran. *J Mazandaran Univ Med Sci* 2013;23(1):215-21. [Link](#)
  23. Jalalizand AR, Fakhari H, Modaresi M, Shayeghi M, Abtahi M. The amount of dursban pesticide residues in Isfahan sugar beet. *Proc Environ Sci* 2011;8:235-9. [Link](#)
  24. Pirsaeheb M, Fattahi N, Karami M, Ghaffari HR. Simultaneous determination of deltamethrin, permethrin and malathion in stored wheat samples using continuous sample drop flow microextraction followed by HPLC-UV. *J Food Measur Characterizat* 2018;12(1):118-27. [Link](#)
  25. Shokrzadeh M, Karami M, Jafari Valoujaei M, Zamani Renani A. Measuring diazinon residue in thompson orange. *J Mazandaran Univ Med Sci* 2013;23(105):91-9. [Link](#)
  26. Shokrzadeh M, Saravi S. The investigation and measurement of residues of Benomyl and Mancozeb pesticides in shrub and nonshrub cucumbers sampled from different regions of Mazandaran Province (Iran). *Electr J Environ Agric Food Chem* 2009;8(3):174-8. [Link](#)
  27. Saeedi Saravi S, Shokrzadeh M. Effects of washing, peeling, storage, and fermentation on residue contents of carbaryl and mancozeb in cucumbers grown in greenhouses. *Toxicol Ind Health* 2016;32(6):1135-42. [PMID: 25342670](#)
  28. Shokrzadeh M, Saeedi Saravi SS, Zehtab Yazdi Y. Lindane residues in cultivated cucumber and in the most consumed fish in Caspian Sea (Iran). *Toxicol Ind Health* 2009;25(8):517-23. [PMID: 19825858](#)
  29. Pirsaeheb M, Fattahi N, Rahimi R, Sharafi K, Ghaffari HR. Evaluation of abamectin, diazinon and chlorpyrifos pesticide residues in apple product of Mahabad region gardens: Iran in 2014. *Food Chem* 2017;231:148-55. [PMID: 28449991](#)
  30. Davodi M, Esmaili-Sari A, Bahramifarr N. Concentration of polychlorinated biphenyls and organochlorine pesticides in some edible fish species from the Shadegan Marshes (Iran). *Ecotoxicol Environ Saf* 2011;74(3):294-300. [PMID: 21168210](#)
  31. Ebadi A, Shokrzadeh M. A survey and measurement of residues of lindane (organochlorine pesticides) in four species of the most consumed fish in the Caspian Sea (Iran). *Toxicol Ind Health* 2006;22(1):53-8. [PMID: 16572712](#)
  32. Shokrzadeh M, Karimi M, Mohammadi H. Diazinon residues in rutilus frisii kutum, cyprinus carpio, and leaping mullet in central coast of the Caspian Sea. *J Mazandaran Univ Med Sci* 2016;25(134):183-92. [Link](#)
  33. Mohebbi-Nozar SL, Ismail WR, Zakaria MP, Mortazavi MS, Zahed MA, Jahanlu A. Health risk of PCBs and DDTs in seafood from Southern Iran. *Hum Ecol Risk Assess* 2014;20(5):1164-76. [Link](#)
  34. Bayat S, Sari AE, Bahramifar N, Younesi H, Behrooz RD. Survey of organochlorine pesticides and polychlorinated biphenyls in commercial pasteurized milk in Iran. *Environ Monit Assess* 2011;175(1-4):469-74. [PMID: 20556646](#)
  35. Amirahmadi M, Shoeibi S, Abdollahi M, Rastegar H, Khosrokhavar R, Hamedani MP. Monitoring of some pesticides residue in consumed tea in Tehran market. *Iran J Environ Health Sci Eng* 2013;10(1):9. [PMID: 23369650](#)
  36. Shah SH, Khorasgani ZN, Masjedi NA. Identification and determination of herbicide residues in wheat by HPLC. *Toxicol Lett* 2008(180):S169. [Link](#)
  37. Khorasgani ZN, Hemmati AA, Ashtarinezh A.

- Occurrence pesticide residues in produced sugar from sugarcane. *Toxicol Lett* 2008;180:S193-4. [Link](#)
38. Tehrani B, Sobhanardakani S. Determination of propineb residue in consumed tea. *Tehran Univ Med J* 2016;74(6):442-7. [Link](#)
  39. Shakoori A, Yazdanpanah H, Kobarfard F, Shojaee MH, Salamzadeh J. The effects of house cooking process on residue concentrations of 41 multi-class pesticides in rice. *Iran J Pharm Res* 2018;17(2):571-84. [PMID: 29881415](#)
  40. Razzaghi N, Ziarati P, Rastegar H, Shoeibi S, Amirahmadi M, Conti GO, et al. The concentration and probabilistic health risk assessment of pesticide residues in commercially available olive oils in Iran. *Food Chem Toxicol* 2018;120:32-40. [PMID: 29986829](#)