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PESTICIDE RESIDUE ANALYSIS IN SEASONAL FRUITS FROM CHARKHI- DADRI, JHAJJAR AND GURGAON DISTRICTS OF HARYANA, INDIA

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ABSTRACT

The use of pesticides cannot be avoided now days in agriculture practices to remain self sufficient in food demand and supply. The extensive and non judicious use of pesticides in agriculture practices and their metabolites in food commodities (fruits, vegetables, cereal, milk, water etc.) persist in environment which results pollution. Food and agriculture organization (FAO) and world health organization have prescribed the maximum residue limit (MRL) values for each pesticide in food commodities which helps in evaluation of pesticides. The present study was conducted on 75 seasonal fruit samples like guava, keenu, aadu, musk mellon, papaya, pear, mango, apple, grapes, pomegranate, litchi, plum etc. All the samples were collected from Jhajjar, Charkhi Dadri and Gurgaon mandies, different districts of Haryana, processed and analyzed by Quick ,Easy ,Cheap, Effective, Rugged and Safe (QuEChERS) method. 27 Organochlorines (OCs) synthetic Pyrethroids (SPs) and 24 Organophosphorus (OPs) were considered for analysis. The quantification was done by Gas Chromatography with ECD and FPD detectors. The recovery results varied from 70% to 118%. Limit of detection (LOD) ranged from 0.001-0.020 mg/kg for OPS, OCs and SPs respectively. Thirty pesticides were detected in the samples with range of 0.00320-3.535mg/kg. In most of the samples, aldrin, Pendimethalin, alfa and beta Endosulfan, lamda- Cyhalothrin, Fluvalinate, ∑DDT, ∑HCH, Cypermethrin, Deltamethrin, Fenvalerate, Dicofol, Dieldrin, Ethion, Malathion,Edifinfos, Chlorpyrifos, Chlorfenvinfos, Phorate, Phosphomidon, Acephate, Phosalane, Anilofos, Paraxon methyl, Quinalphos Fiuvlinate and Profenofos were detected. In some fruits, the detected pesticides were above the MRL (Prevention of Food Adulteration Act 1954).

INTRODUCTION

Fruits are important components of the human diet since they provide essential nutrients that are required for most of the reactions occurring in the body. Like other crops, fruits are also attacked by pests and diseases during production and storage that affect the quality and the yield. Pesticides are substances or mixture of substances intended for preventing, destroying, repelling any pest in order to raise the yields in agriculture and preventing other harmful effects [1].

The controlled use pesticide does not affect the environment but uncontrolled pesticide use will cause adverse impacts on the environment such as water, soil and air pollution that cause unbalance ecosystems. In order to reduce the loss and maintain the quality of fruits harvest, pesticides are used together with other pest management techniques during cropping to destroy pests and prevent diseases. Due to intensive use of pesticides, their residues have become an unavoidable part of the environment and they are often detected in all environmental segments. Hence, their monitoring has been frequently performed throughout the world. Because of wide spread use of pesticides, the presences of their toxic residues have been reported in various environmental component or commodities [2- 13].

Pesticide residues find their way into the human body through food, water and environment. Thus, analysis of pesticide residue in food and other environmental commodities like fruits, vegetables and total diet have become essential requirement for consumers, producers and food quality control authorities. The concern has led to governments setting up monitoring systems in order to assess the safety situation and make informed decisions when passing legislation. Studies have shown that long-term, low-dose exposure to pesticides leads to the development of respiratory diseases such as asthma [14]**.** Toxicological and epidemiologic studies have demonstrated the association between acute and high levels of OP (Organophosphorus) exposure and adverse health effects. The establishment of the relation between neurologic impairments and repeated low-level OP (organophosphorus) exposure that does not induce symptoms of acute poisoning in humans is far less concrete [15- 17]. Indiscriminate use and improper handling of pesticides in agriculture have caused serious health problems in many developing countries which represent 30% of the global pesticide consumer market [18]**.**

Thus, analysis of pesticide residue in food and other environmental commodities like fruits, vegetables and total diet have become essential requirement for consumers, producers and food quality control authorities. To assess the present environmental load of the pesticide residue, it is imperative to determine the amount of pesticide residue in fruit samples in Delhi NCR region like

Charkhi Dadri & Jhajjar Districts of Haryana. The study also includes the application of Quick, Easy, Cheap, Effective, Rugged and Safe (QuEChERS) methods [19- 21] for the estimation of pesticides comprising organochlorines (OCs), organophosphorous (OPs) and synthetic pyrethriods (SPs) in seasonal fruit.

MATERIALS AND METHODS

Chemicals

Solvents like n-hexane, ethyl acetate (HPLC Grade) were purchased from Merck, India. Sodium sulfate, Sodium Chloride, Sodium bicarbonate and Magnesium sulphate were procured from Merck, India. PSA was purchased from Agilant. Certified Reference Material (CRM) of all the pesticides were purchased from Sigma Aldrich.

Sample Collection

75 samples of seasonal fruits were collected from mandies of Charkhi Dadri, Gurgaon and Jhajjar districts of Haryana. Aadu, cheeku(sapota), plum, litchi, foot(variety of muskmelon), muskmelon, mango, banana, sweet lime, khurmani, apple, guava, papaya, nashpati, babugosa, pomegranate, keenu and grapes were collected from Gurgaon mandi. Aadu, cheeku(sapota), plum, litchi, foot(variety of muskmelon),, muskmelon, mango, banana, sweet lime, apple, guava, papaya, nashpati, babugosa, pomegranate, keenu, and grapes were collected from Charkhi Dadri mandi. Cheeku (sapota), plum, litchi, mango, banana, sweet lime, guava, muskmelon, pomogranate, apple, keenu, and grapes were collected from Jhajjar mandi.

Extraction and Cleanup

The collected fresh samples (100gm) were washed, cleaned, chopped and grinded in blender.10 gm grinded sample of each fruit was taken for multi-residue analysis by QuEChERS method. 10 gm of macerated sample was mixed with 20 ml ethyl acetate, 6.6 g of sodium sulphate and 1.0g of sodium bicarbonate and shaked for 10 min at 50 rpm using rota spin. The extract was centrifuged for 5 minutes at 3000-4000 rpm. 6 ml aliquot fruit sample was cleaned with the mixture of 0.100g of PSA, 0.6 g of anhydrous Magnesium sulfate and 0.033g of activated charcoal. The extract was again shaken for 2 min. at vertex and centrifuged for 5 min. at 2000-3000 rpm. 4 ml supernatant was collected and kept in turbovap for complete drying. The dried mass was reconstituted in 1 ml hexane and transferred in vial. Sample was then injected in Gas Chromatography-Electron Capture Detector (GC-ECD) for the quantification of OCs and SPs, in Gas Chromatography-Flame Photometric Detector (GC-FPD) for the quantification of OPs and in Gas Chromatography-Mass Spectrometry (GC-MS) for confirmation.

Analysis

GC-ECD

The final extracts were analyzed on GC (Schimadzu GC- 2010) equipped with fused silica capillary column DB-5(30 mm×0.25 mm) coated with 5% phenyl methoxysiloxane using ^{63}Ni detector (ECD) for OCs, SPs and herbicides . General operating conditions were as follows:

Column temperature program: initially 170º C for 5 min. increase at 2ºC/min to 210ºC hold for 5 min., increase at1ºC/min to 215ºC hold for 5 min., then 280ºC increase at 4ºC/min. hold for 8min.

Injection volume: 1micro litre, nitrogen flow rate at 0.75 ml/min. and makeup 60ml/min with split ratio 1:10; using carrier gas (N_2) 99.9%: Injector port temperature 280ºC; detector temperature 300ºC.

GC-FPD

The remaining extract were analyzed on GC-FPD equipped with fused silica capillary column DB-5 (30 mm×0.25 mm) coated with 5% phenyl methoxysiloxane using flame photo meteric detector. General operating conditions were as follows:

Column temp program : initially 100 ºC for 2 min, increase at 25ºC/min to 200 ºC hold for5 min., increase at 4ºC/min to 230ºC hold for 2 min., then increase at the rate 20ºC/min. to 280ºC and hold for 5 minutes .

Injection volume: 1micro litre, nitrogen flow rate at 16.6 ml/min., using (N_2) as carrier gas: Injector port temp 250ºC Detector temp 290ºC.

GC-MS

The chromatographic procedure was performed using GC-MS model MSQP2010 (Shimadzu, Kyoto, Japan) with auto sampler. 1000 ppm solution in methanol, ethylacetate and hexane were prepared from three extracts (methanol, ethylacetate and hexane) and 1 µL of each extract was injected for analysis using DB -5MS column (30 meter × 0.25 mm, film thickness 0.25µm). Helium gas was used at flow rate 1ml/min. as a carrier gas. The analysis was carried out using oven programming of initial temperature 50˚C for 2 minutes followed by ramp rate of 20˚C/minute up to 130˚C followed by ramp of 12˚C/min. to a temperature of 180˚C, finally raised temperature to 280˚C at 3˚C per minute and hold for 15 minutes. The ion source temperature was set at 250˚C. The injection port temperature was set as a 250˚C and the total run time was 58.5 minute. The instrument was operated in electron impact (EI) mode with electron energy 70ev.

RESULT AND DISCUSSION

The recovery results and limit of detection (LOD) of pesticides in 18 fruits are shown in table1.The analyzed pesticides are Dichlorvos, Monocrotophos, Phorate, Dimethoate, Diazinon, Chlorpyrifos-Me, Malaxon. Parathion-Me, Malathion, Chlorpyrifos, Fenthion, Paraxon-Me, Chlorfenvinfos, Profenofos, Ethion, Triazofos, Parathion, Phosalane, Phosphomidon, Fenamifos, Dialdrin, Aldrin, o,p-DDT, p,p'-DDT, o,p-DDD, alfa-Endosulfan, beta-Endosulfan, Bifenthrin, lamda-Cyhalothrin, beta-Cyfluthrin, Deltamethrin, Fluvalinate, Alachor, alfa-HCH beta-HCH, gamma-HCH, Fenpropathrin, Fenvalerate, Butachlor, Cypermethrin, Dicofol, Pendimethalin, Acephate, Anilofos, Quinalfos, Edifinfos. LOD of following pesticides varied from 0.001-0.020mg/Kg. Similarly, the percent recovery of OCs, SPs and Herbicides varies from 79.23-97.14% from the fortification level of 0.1mg/Kg. The percent recovery of OPs ranged from 74.1-95.54% at the fortification level of 0.1mg/Kg.

Detected pesticides in analyzed fruit samples are given in table 2. The pesticide residue recorded below the detection limit was considered as non detectable (ND). The level of pesticide residues in various fruits are compared with their MRL, fixed by Prevention of Food Adulteration Act (PFA), Govt, of India, 1954. In banana , the detected range of pesticide residues were, Aldrin (0.00396-0.00774 mg/Kg), Pendimethalin (BDL-0.0897 mg/Kg), Chlorpyrifos (0.00477-0.078 mg/Kg), p,p'-DDT (0.830 mg/Kg), delta-HCH (0.0362-0.0066 mg/Kg), gamma- HCH (0.0223 mg/Kg), o,p-DDT (0.0234 mg/Kg), Fenvalerate (0.3139 mg/Kg), Fluvalinate (0.413 mg/Kg), Chlorpyrifos- Me (0.003129 mg/Kg), Parathion (0.00172 mg/Kg), Ethion (0.1260 mg/Kg) and Phosalane (0.0114 mg/Kg). But none of this pesticide was above MRL. In apple, aldrin (0.0025-0.036mg/Kg), Chlorpyrifos (0.00133-0.129 mg/Kg), Cypermethrin (0.1268 mg/Kg), beta-HCH (0.087 mg/Kg), Fenvalerate (0.8018 mg/Kg), Fluvalinate (1.113 mg/Kg), Phorate (0.1029 mg/Kg) and Phosalane (0.0328 mg/Kg) were detected. The pesticide detected in cheeku were Edifinfos (0.0267 mg/Kg), Aldrin(0.02066 mg/Kg), beta-cyfluthrin (0.1083), Chlorpyrifos (0.0012-0.080), o,p-DDT (0.1559), p,p'-DDE(0.1458), o,p-DDD(0.0231), gamma-HCH(0.0087-0.0321 mg/Kg), Dicofol(0.0546-0.415 mg/Kg), lamda-Cyhalothrin (0.315 mg/Kg), Fenvalerate (0.0464-0.1457 mg/Kg), Aldrin (0.00656-0.0746 mg/Kg) and Bifenthrin (0.463mg/Kg). In Pomogrante, pesticide like alfa- Cypermethrin (0.0500-0.0891 mg/Kg), Chlorpyrifos (0.0.0047-0.2388 mg/Kg), Aldrin (0.0354-0.0475 mg/Kg), Fenvalerate (00.2438-0.7591 mg/Kg), Fluvalinate (0.3106 mg/Kg), Phorate (0.0508 mg/Kg), Chlorfenvinfos (0.00884 mg/Kg), Alachor(0.1777 mg/Kg),

Cyhalothrin(0.0490 mg/Kg), Fenpropathrin(0.1230 mg/Kg) and Deltamethrin (0.0338 mg/Kg) were detected.

In grapes, the detected pesticides were Dicofol (0.4630 mg/Kg), Chlorpyrifos (0.00028-0.0257 mg/Kg), Aldrin (0.0376 mg/Kg), p,p'-DDD (0.0373 mg/Kg), Fluvalinate (0.3170 mg/Kg), Chlorfenvinfos (0.00115 mg/Kg) and Cypermethrin (0.0882 mg/Kg). In mango (0.0447 mg/Kg), Chlorpyrifos (0.0712-0.0854 mg/Kg), Chlorpyrifos-Me (0.0712 mg/Kg) were detected. Alfa-Endosulfan (0.0139 mg/Kg), Chlorpyrifos- Me (0.0061 mg/Kg) gamma-HCH (0.0215 mg/Kg), Dialdrin (0.112 mg/Kg), and Chlorpyrifos (0.00831-0.0503 mg/Kg) were found in muskmelon.

In guava, Edifinfos (0.0267 mg/Kg), Phosalane (0.0065 mg/Kg), Anilofos (0.1084 mg/Kg), alfa-HCH (0.0110-0.100mg/Kg), Chlorpyrifos (0.0043-0.0519mg/Kg), delta-HCH (0.0108-0.1507mg/Kg), Fenvalerate (0.1509-0.1981 mg/Kg), Alachor (0.0883-0.0214 mg/Kg), Pendimethalin (0.00380 mg/Kg), alfa- Endosulfan (0.00602 mg/Kg), gamma-HCH (0.0652 mg/Kg) and Fluvalinate (0.1735 mg/Kg) were detected. In keenu, pesticides were Chlorpyrifos (0.00139 mg/Kg mg/Kg), Phosalane (0.00399 mg/Kg), Alachor (0.0746 mg/Kg), Aldrin (0.0102 mg/Kg), Fenvalerate (0.0464 mg/Kg), Chlorfenvinfos (0.543 mg/Kg), Edifinifos (0.00503 mg/Kg), Endosulfan-II (0.0032 mg/Kg), gamma-HCH (0.0044 mg/Kg), Malathion (0.0264 mg/Kg) and Edifinfos (0.0889 mg/Kg). In babugosa, gamma-HCH (0.0135-0.0215 mg/Kg), Deltmethrin (0.1606 mg/Kg) and Chlorpyrifos (0.00200 mg/Kg) were detected. In litchi, p,p'-DDD (0.0453-0.0586 mg/Kg), Chlorpyrifos (0.0127 mg/Kg), Profenofos (1.8098 mg/Kg), Chlorpyrifos- Me (0.0168 mg/Kg) and quinalfos (0.0151 mg/Kg) were detected.

In nashpati, gamma-HCH (0.0183-0.022 mg/Kg), p,p'-DDT (0.0470-0.872 mg/Kg) and Ethion (0.944 mg/Kg) were detected. In foot (variety of muskmelon), Chlorpyrifos (0.0158 mg/Kg), p,p'-DDD (0.0453 mg/Kg), Chlorpyrifos-Me (0.0047 mg/Kg) were detected. In papaya, Fluvalinate (0.0936-0.223 mg/Kg), and Fenvalerate (0.3151-0.3437 mg/Kg) were detected. In plum, pesticide detected were p,p'-DDD (0.0252-0.0258 mg/Kg) and Chlorpyrifos-Me (0.00281 mg/Kg). In Aadu Chlorpyrifos (0.00175 mg/Kg) were detected. In sweet lime, p,p'-DDT(0.0267 mg/Kg), Fluvalinate (3.535 mg/Kg), Chlorpyrifos (0.0012-0.0080 mg/Kg), o,p-DDT (0.1559 mg/Kg), p,p'-DDE (0.1458 mg/Kg), Endosulfan -II (0.0087-0.0321 mg/Kg), Dicofol (0.0546-0.415 mg/Kg), o,p-DDD (0.0231 mg/Kg) and Fenvalerate (0.0464-0.1457 mg/Kg) were detected. High concentration of Profenofos was found 1.809 mg/Kg in litchi. High concentration of Fluvalinate was found 3.535mg/Kg in sweet lime and 1.113mg/Kg in apple. MRL of profenofos and fluvalinate was not reported by PFA (1954).

The pattern of presence of pesticide residue was in the following order: banana> apple> guava> pomegranate> cheeku(sapota)> keenu> nashpati> babugosa> sweet lime> Papaya> musk melon> foot(variety of muskmelon) > grapes> plum> aadu> khurmani. The presence of pesticide residues in fruits has become a word wide phenomenon today.

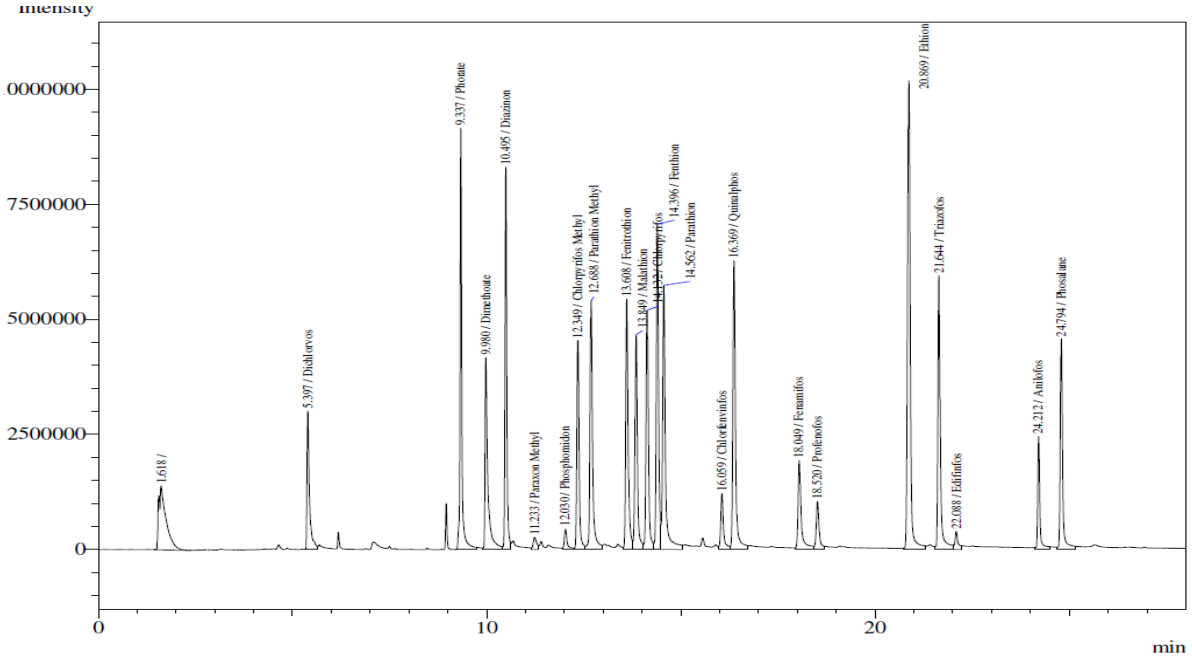

Fig.1 GC-FPD chromatogram of pesticides mixture of 1.0ppm

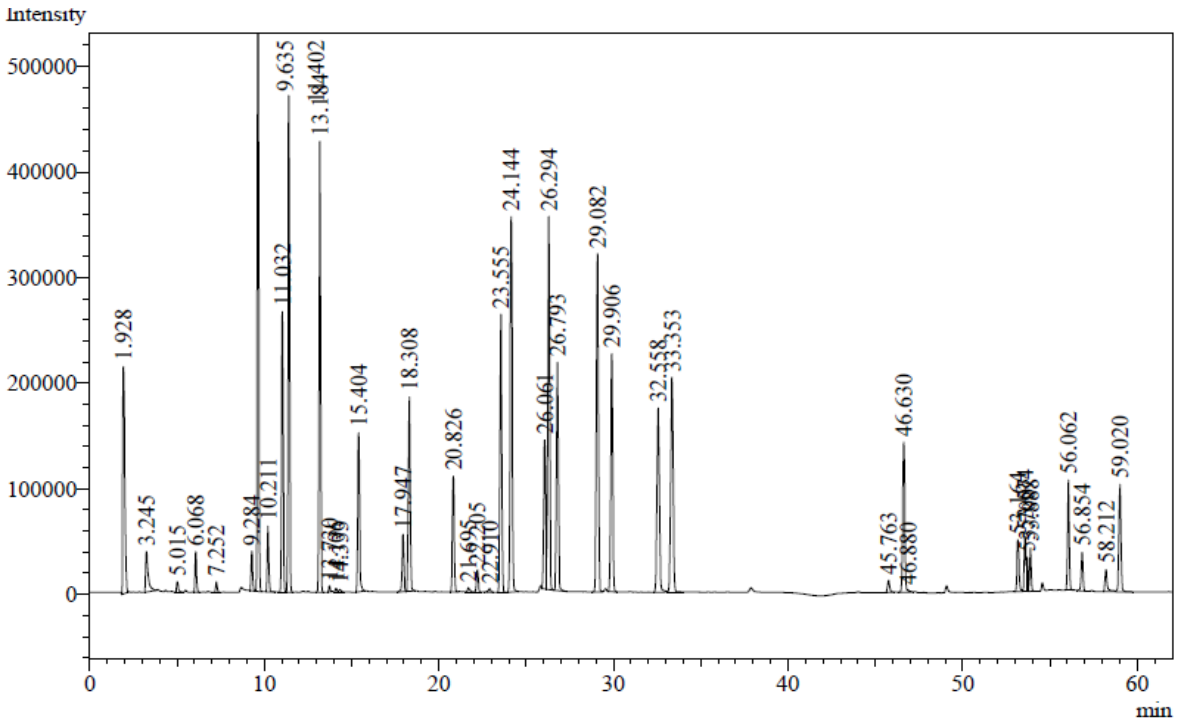

Fig.2 GC-ECD chromatogram of pesticides mixture of 1.0ppm

Table 1: THE PERCENT RECOVERIES AND LIMIT OF DETECTION OF FORTIFIED FRUIT SAMPLES

S. NO.	Pesticides	Fortification Level	Recovery (%)	Limit of Detection (mg kg^{-1})	Limit of Quantification (mg kg^{-1})
		Organophosphorus pesticides			
1	Dichlorvos	0.10	85.7	0.003	0.010
2	Monochrotophos	0.10	95.5	0.02	0.062
3	Phorate	0.10	90.24	0.010	0.033
4	Dimethoate	0.10	82.4	0.003	0.01
5	Diazinon	0.10	74.12	0.001	0.004
6	Chlorpyrifos- me	0.10	87.67	0.003	0.010
7	Malaxon	0.10	87	0.002	0.006
8	Parathion-me	0.10	91.12	0.001	0.003
9	Malathion	0.10	87.82	0.020	0.061
10	Chlorpyrifos	0.10	91.02	0.002	0.006
11	Fenthion	0.10	89	0.003	0.009
12	Paraxon Me	0.10	83.5	0.002	0.006
13	Quinalfos	0.10	95.54	0.020	0.062
14	Chlorfenvifos	0.10	88.21	0.003	0.010
15	Profenofos	0.10	90.02	0.020	0.061
16	Ethion	0.10	95.45	0.005	0.016
17	Triazofos	0.10	89.66	0.001	0.003
18	Anilofos	0.10	80.0	0.002	0.006
19	Fenitrothion	0.10	73.52	0.010	0.034
20	Edifinfos	0.10	85.2	0.001	0.003
21	Parathion	0.10	90.5	0.001	0.003
22	Phosalane	0.10	90.0	0.003	0.010
23	Phosphomidon	0.10	87.4	0.004	0.009
24	Fenamifos	0.10	86.4	0.003	0.010
		Organochlorine and Synthetic Pyrithroid Pesticides			
1	alpha HCH	0.10	90.02	0.001	0.003
2	Dialdrin	0.10	94.0	0.002	0.006
3	o,p DDD	0.10	92.07	0.003	0.010
4	beta Endosulfan	0.10	96.82	0.001	0.003
5	o,p DDT	0.10	84.92	0.002	0.007
6	p,p DDT	0.10	92.52	0.003	0.006
7	Bifenthrin	0.10	74.2	0.003	0.010
8	Lamda Cyhalothrin	0.10	97.14	0.004	0.014
9	alpha Endosulfan	0.10	95.27	0.002	0.006
10	o,p- DDE	0.10	94.12	0.008	0.026
11	Deltamethrin	0.10	80.08	0.005	0.012
12	Fluvalinate	0.10	102	0.002	0.007
13	Alachor	0.10	88.25	0.010	0.030
14	Aldrin	0.10	84.2	0.001	0.003
15	Beta- Cyfluthrin	0.10	70.5	0.002	0.006
16	Beta-HCH	0.10	92.04	0.004	0.014
17	Delta-HCH	0.10	90.05	0.006	0.020
18	Dicofol	0.10	82.5	0.003	0.009
19	Fenpropathrin	0.10	77.5	0.002	0.006
20	Fenvalerate	0.10	86.74	0.007	0.016
21	Gama-HCH	0.10	88.82	0.009	0.030
22	p,p'-DDD	0.10	89.5	0.003	0.010
23	p.p'-DDT	0.10	95.2	0.005	0.018
24	p,p'-DDE	0.10	88.58	0.002	0.007
25	Pendimethalin	0.10	90.34	0.030	0.10
26	Endosulfan sulfate	0.10	92.26	0.004	0.012
27	Cypermethrin	0.10	79.23	0.007	0.023
28	Butachlor	0.10	94.10	0.004	0.014

Table 2: LEVEL OF PESTICIDE RESIDUES IN FRUIT SAMPLES

S.No.	Fruit name	Pesticide detected	Number of Samples		No. of samples above MRL	Residue range: mg kg^{-1}
			Analyzed	Detected		
1.	Banana	Aldrin	9	2	0	(0.00396-0.00774)
		Pendimethrin	9	1	NA	(ND -0.0897)
		Chlorpyrifos	9	4	0	(0.00477-0.0854)
		p,p- DDT	9	1	0	(ND-0.830)
		gamma -HCH,	9	1	0	(ND-0.0223)
		delta-HCH	9	2	0	(0.0362-0.0066)
		o,pDDT	9	1	0	(ND-0.0234)
		Fenvalerate	9	1	NA	(ND-0.3139)
		Fluvalinate	9	1	NA	(ND-0.413)
		Chlorpyrifos -Me	9	1	0	(ND- 0.003129)
		Parathion	9	1	0	(ND- 0.00172)
		Ethion	9	1	0	(ND-0.1260)
		Phosalane	9	1	0	(ND-0.0114)
2.	Litchi	p,p'- DDD	3	2	0	(0.0576-0.0586)
		Chlorpyrifos	3	1	0	(ND-0.0127)
		Profenofos	3	1	1	(ND-**1.8098**)
		Chlorpyrifos -Me	3	1	NA	(ND-0.0168)
		Quinalfos	3	1	NA	(ND-0.0151)
3.	Cheeku (Sapota)	Aldrin	8	6	0	(ND-0.02066)
		p,p'-DDD	8	1	0	(ND-0.0258)
		gamma-HCH	8	1	0	(0.0121-0.2580)
		Alachor	8	3	0	(ND-0.0345)
		Deltamethrin	8	1	0	(ND-0.0498)
		Cypermethrin	8	1	0	(ND-0.0956)
		Fluvalinate,	8	1	0	(ND-0.0466)
		beta- Cyfluthrin,	8	1	0	(ND-0.1083)
		Edifinfos	8	1	0	(ND-0.0267)
		Chlorpyrifos,	8	1	0	(0.0036-0.0333)
		Chlorpyrifos-Me	8	4	0	(ND-0.00578)
4.	Mango	p,p'- DDD	3	1	0	(ND-0.0447)
		Chlorpyrifos	3	2	0	(0.0149-0.0712)
		Chlorpyrifos-Me	3	1	0	(ND-0.0712)
5.	Apple	Aldrin	5	1	0	(ND-0.00295)
		alpha-Cypermethrin	5	1	0	(ND-0.1268)
		Chlorpyrifos	5	5	0	(0.00133-0.0590)
		Phosalane	5	1	0	(ND-0.0328)
		Phorate	5	1	1	(ND-0.1029)
		Fluvalinate	5	1	NA	(ND-**1.113)**
		beta-HCH	5	1	0	(ND-0.087)
6.	Sweet lime	Endosulfone-II	8	3	0	(0.0656-0.0868)
		p,p'-DDT,	8	1	0	(ND-0.0267)
		Dicofol	8	2	0	(0.0546-0.415)

		o,p-DDD	8	1	0	(ND-0.0231)
		o,p-DDT	8	1	0	(ND-0.1559)
		gamma-HCH,	8	2	0	(0.0087-0.0321)
		p,p'-DDE	8	1	0	(ND-0.1458)
		Fluvalinate	8	1	1	(ND-**3.535)**
		Fenvalerate	8	2	NA	(0.0464-0.1457)
		Chlorpyrifos	8	5	0	(0.0012-0.080)
		Aldrin	8	3	0	(0.00656-0.0746)
		Bifenthrin	8	1	0	(ND-0.463)
		p,p-DDE	8	1	0	(ND-0.1458)
7.	Grapes	Chlorpyrifos	4	3	0	(0.00028-0.0257)
		Dicofol,	4	1	0	(ND-0.04630)
		Aldrin	4	1	NA	(ND-0.0376)
		p,p'-DDD	4	1	NA	(ND-0.0373)
		Fluvalinate	4	1	0	(ND - 0.3170)
		Chlorfenvinfos	4	1	0	(ND-0.00115)
		Cypermethrin	4	1	NA	(ND-0.0882)
8.	Guava	HCH	6	5	0	(0.0108-0.1517)
		Cypermethrin	6	2	0	(0.1507-0.7045)
		Fenvalerate	6	2	0	(0.1509-0.1981)
		Alachor	6	2	NA	(0.0214-0.0883)
		Pendimethrin,	6	1	0	(ND-0.00380)
		alfa-Endosulfan	6	1	0	(ND-0.00602)
		Fluvalinate,	6	1	0	(ND-0.1735)
		Chlorpyrifos	6	5	0	(0.0043-0.0519)
		Edifinfos	6	1	NA	(ND-0.0267)
		Phosalane	6	1	0	(ND-0.0065)
9.	Babugosa	gama-HCH,	2	2	0	(0.0135-0.0215)
		Deltamethrin	2	1	0	(ND-0.1606)
		Chlorpyrifos	2	1	0	ND-0.00208)
10.	Plum	p,p'-DDD	3	2	0	(0.0252-0.258)
		Chlorpyrifos-Me	3	1	0	(ND-0.00281)
11.	Papaya	Fenvalerate	4	2	NA	(0.3151-0.3437)
		Fluvalinate	4	2	NA	(0.0936-0.223)
		Chlorpyrifos	4	1	0	(ND-0.0054)
12.	Pomogranate	Fenvalerate	5	2	NA	(0.2438-0.7591)
		Cypermethrin,	5	4	0	(0.0352-0.268)
		Alachor	5	1	NA	(ND-0.1777)
		Aldrin,	5	2	0	(0.0354-0.0475)
		lamda-Cyhalothrin	5	1	NA	(ND-0.0490)
		Fenpropathrin	5	1	NA	(ND-0.120)
		Deltamethrin	5	1	NA	(ND-0.0338)
		Chlorfenvinfos	5	1	NA	(ND-0.00884)
		Chlorpyrifos	5	5	0	(0.00388-0.2388)
		Fluvalinate	5	1	NA	(ND-0.3106)
		Phorate	5	1	0	(ND-0.0508)
13.	Aadu	Chlorpyrifos	2	1	0	(ND-0.00175)
14.	Nashpati	gamma-HCH	2	2	0	(0.183-0.022)

		p,p'-DDT	2	2	0	(0.0872-0.0470)
		Ethion,	2	1	0	(ND-0.944)
		Chlorpyrifos	2	1	0	(ND-0.0023)
15.	Keenu	Alachor	3	1	NA	(ND-0.0746)
		Aldrin	3	1	0	(ND-0.0102)
		Fenvalerate,	3	1	NA	(ND-0.0464)
		Endosulfone-II	3	1	0	(ND-0.0032)
		gamma-HCH,	3	1	0	(ND-0.0044
		Chlorfenvinfos	3	1	NA	(ND-0.543)
		Edifinfos	3	1	NA	(ND-0.0889)
		Malathion	3	1	0	(ND-0.0264)
		Chlorpyrifos	3	1	0	(ND-0.00139)
		Phosalane	3	1	0	(ND-0.00399)
16.	Muskmelon	gamma-HCH	5	1	0	(ND-0.0215)
		Dialdrin,	5	1	0	(ND-0.1122)
		alfa-Endosulfan	5	1	0	(ND-0.0139)
		Chlorpyrifos-Me	5	1	0	(ND-0.0061)
		Chlorpyrifos	5	2	0	(0.00831-0.0503)
17.	Foot	p,p'-DDD,	2	1	0	(ND-0.0453)
	(variety of	Chlorpyrifos	2	1	0	(ND-0.0158)
	muskmelon)	Chlorpyrifos-Me	2	1	0	(ND-0.0047)
18.	Khurmani	ND	1	0	ND	ND

CONCLUSION

Most of the seasonal fruits which were analyzed are found contaminated with pesticide residues. But it has been observed that analyzed pesticide residues are below MRL in approximately 96% of the fruits samples. Profenofos in litchi from Jhajjar, fluvalinate in apple and sweet lime from Gurugram and Jhajjar districts respectively are found above MRL. To provide adequate food for growing population, the usage of pesticide is necessary but dissemination of information regarding food safety pesticide handling and good agricultural practice (GAP) among farmers are also needed. A periodic monitoring of pesticide residue in fruits and other commodities is necessary for maintaining the health of the consumers. There is a need for awareness among farmers so that excess use of pesticides can be controlled. Strict action is necessary against the illegal use of pesticides. Moreover, good agricultural practices and household processes are the important and effective tools in minimizing pesticide residue in food commodities.

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