
Comparative Study of Pesticide Residue in Seasonal Fruits from Charkhi Dadri, Gurgaon & Jhajjar Districts of Haryana (India)

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ABSTRACT

Pesticides are among the most widely used chemicals in the world. The controlled and judicious use of pesticides does not affect the environment but uncontrolled and unjudicious use of pesticides causes adverse impacts on the environment such as water, soil and air pollution that cause unbalance ecosystems. The present work describes an efficient and effective analytical method to screen pesticides in seasonal fruits collected from local markets of Charkhi Dadri, Gurgaon and Jhajjar districts of Haryana from June 2015-Dec. 2016. A quick, easy, cheap, effective, rugged and safe method (QuEChERS) method was used for sample preparation which has previously shown to yield high quality results for pesticide residues in food items.

The study was conducted on 136 seasonal fruit samples like guava, muskmelon, keenu, pear, mango, apple, grapes, pomegranate, litchi, plum etc. 28 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 102%. 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 0.00028-6.477 mg/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 and Profenofos were detected in fruits. Most of the fruits which were analyzed were contaminated with pesticide residues. Pesticides were detected in about 80.147% of the samples collected from different locations But it has been observed that analyzed pesticide residues were above MRL in approximately 41.911% of the fruit samples. Many samples were found contaminated with multi residue. DDT and their isomers, Lindane, endosulfan, Phosphomidon, Chloropyrifos, bifenthrin, alpha-cyfluthrin, alfa-cypermethrin, deltamethrin, Fenvalerate and Fluvalinate were detected in many samples. Some of the pesticides like Phosphomidon, Profenfos, Chlorpyrifos, Chlorfenvinfos, fluvalinate, Deltamethrin, Fluvalinate, alfa-cypermethrin, phorate, Deltamethrin and Aephate were found above MRL value in some samples. DDD, DDT, Aldrin, ethion, phorate,alachor were found in very low concentrations. Low level of these pesticides in fruits seems to be due to banned or restricted use. Samples collected during August2015- October2015 from Charkhi Dadri, Gurgaon and Jhajjar were contaminated with pesticide residues. Samples collected during February2016-April2016 & May2016-July2016 from Charkhi Dadri, Gurgaon and Jhajjar were found more contaminated than other periods. In some fruits the detected pesticides were above the maximum residue limit (MRL) (PFA 1954).

KEYWORDS: Maximum Residue Limit (MRL), QuEChERS method, GC-ECD, GC-FPD, GC-MS.

INTRODUCTION

Agriculture is the mainstay of the Indian economy. It is a formidable task to ensure food security for more than 1 billion Indian people with shrinking cultivable land resources and this necessitates the use of high yielding variety of seeds, balanced use of fertilizers and judicious application of quality pesticides along with education to farmers for the implementation of modern farming techniques. As per estimates, India approximately loses 18% of the crop yield valued at Rs.900 billion due to pest attack each year^[1]. The average pesticide consumption in India is a low 288 g/ha as compared to the global average of 900 g/ha.^[2] The use of pesticides helps to reduce the crop losses, provide economic benefits to farmers, reduce soil erosion and help to ensure food safety and security for the nation^[3]. Despite the benefits of pesticides in agriculture, some pesticides may pose a serious risk to the environment, to non target organisms and to human health also. In addition to well-documented risks to acute toxicity from some pesticides, epidemiological studies have associated the use of various pesticides with human health risks including reproductive toxicity, developmental effects, neurotoxic effects and respiratory complications^[4,5].

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 essential to determine the amount of pesticide residue in fruit samples in NCR region like Gurgaon, Charkhi Dadri & Jhajjar Districts of Haryana. The study also includes the application of Quick, Easy, Cheap, Effective, Rugged and Safe (QuEChERS) method^[6,7] for the estimation of pesticides comprising organochlorines (OCs), organophosphorous (OPs) synthetic pyrethroids and herbicides in fruits.

MATERIALS AND METHODS

Chemicals

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

Sample Collection

136 samples of seasonal fruits like guava, keenu, babugosa, musk melon, pear, mango, apple, grapes, litchi, plum etc were collected from local markets of Gurgaon, Charkhi Dadri, and Jhajjar districts of Haryana in different seasons during June2015-Dec. 2016.

Extraction and Cleanup

The collected fresh samples (100gm) were washed, cleaned, chopped and grinded in blender. 10gm macerated sample of each fruit was taken for multi-residue analysis by QuEChERS method. 10 gm of crushed sample was mixed with 20ml ethyl acetate, 6.6g of sodium sulfate, 1.0g of sodium bicarbonate and shaken for 10 min at 50rpm using rotospin test tube mixture. 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 2min. at vortex and centrifuged for 5 min. at 2000-3000 rpm. 4 ml supernatant was collected and kept in turbo-vap for complete drying for 15-20 min. The dried mass was reconstituted in 1 ml hexane and transferred in vial.

ANALYSIS

GC-ECD

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

Column temperature program: initially for 170° C for 5 min. increase at 2°C/min to 210°C hold for 5 min., increase at 1°C/min to 215°C hold for 5 min., then 280°C increase at 4°C/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 (N₂) 99.9%: Injection port temperature 280°C ; detector temperature 300°C.

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 photometric detector. General operating conditions were as follows :

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

Injection volume: 1micro litre, nitrogen flow rate at 16.6 ml/min., using (N₂) as carrier gas: Injector port temp 250°C Detector temp 290°C.

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.

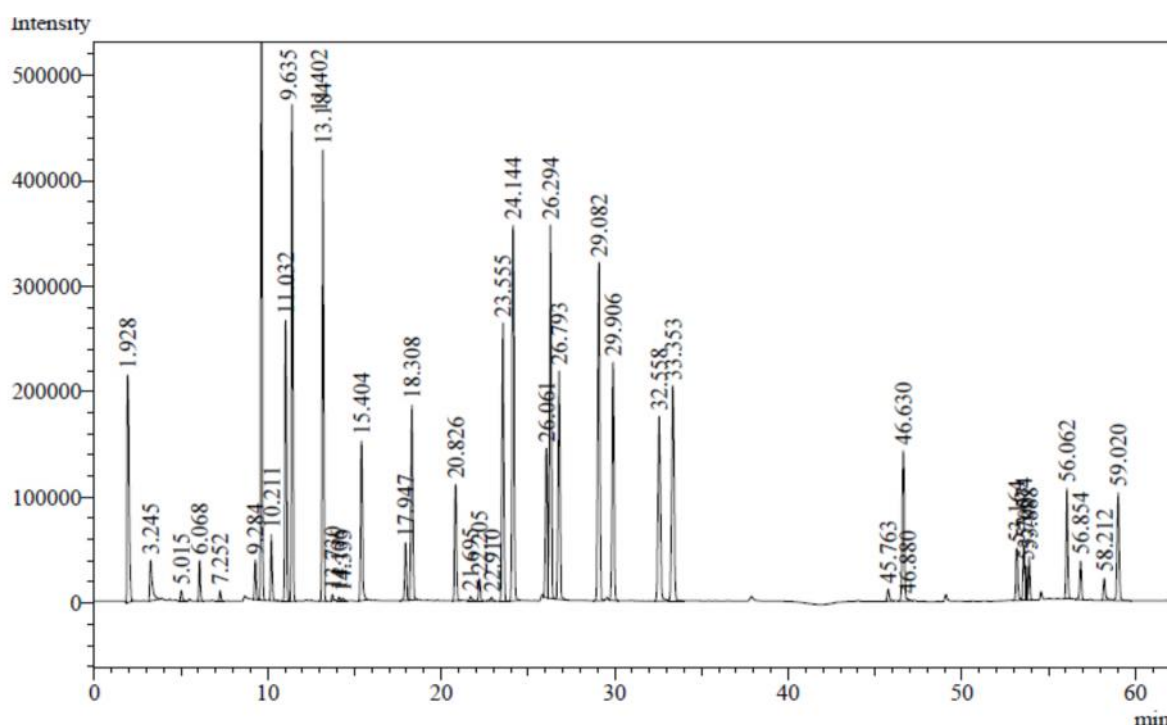


Figure 1: GC-ECD Chromatogram of pesticides Mixture of 1.0ppm

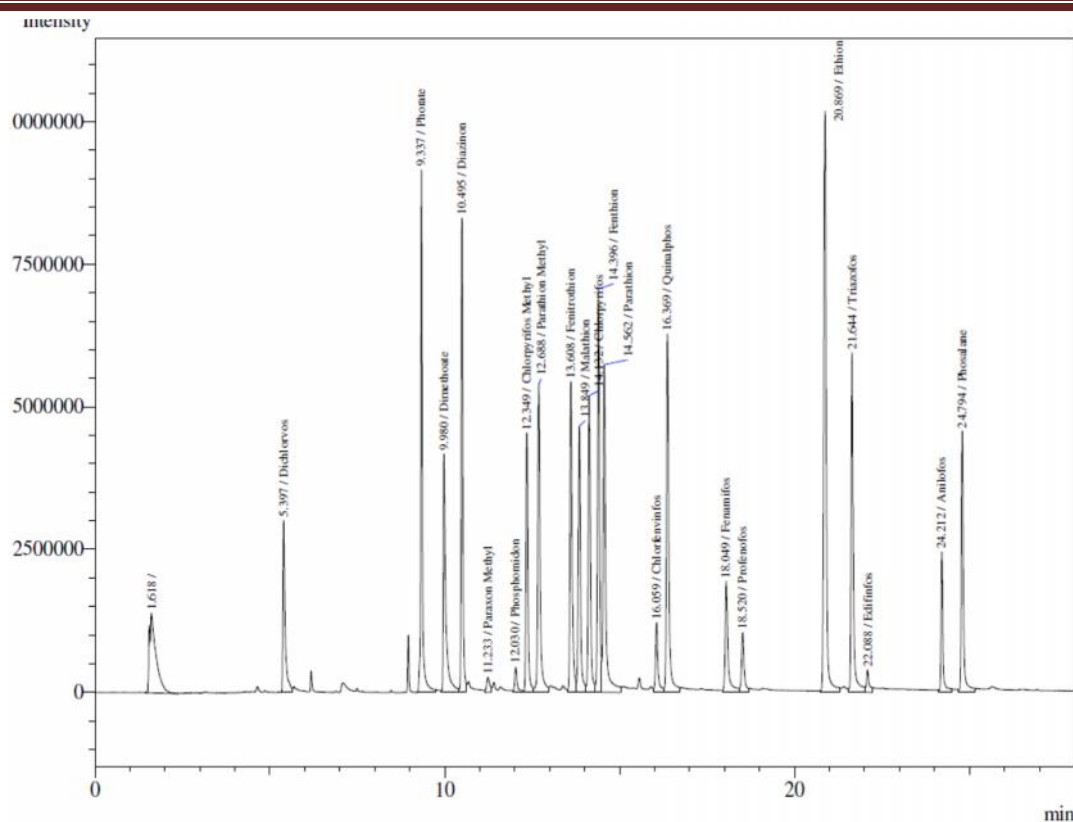


Figure 2: GC-FPD Chromatogram of pesticides Mixture of 1.0ppm

RESULT AND DISCUSSION

The recovery results and limit of detection (LOD) of pesticides in 18 fruits are shown in table 1. The analyzed pesticides were Dichlorvos, Monocrotophos, Phorate, Dimethoate, Diazinon, Chlorpyrifos-Me, Malaxon, Parathion-Me, Malathion, Chlorpyrifos, Fenthion, Paraxon-Me, Chlorfenvifos, Profenfos, Ethion, Triazofos, Parthion, Phosalone, Phosfomidon, Fenamifos, Dieldrin, Aldrin, o,p-DDT, p,p'-DDT, o,p-DDD, alfa-Endosulfan, beta-Endosulfan, Bifenthrin, lamda-Cyhaluthrin, beta-

Cyhalothrin, Deltamethrin, Fluvalinate, Alachor, alfa-HCH, beta-HCH, gamma-HCH, Fenpropathrin, Fenvalerate, Butachlor, Cypermethrin, Butachlor, Cypermethrin, Fenvaierate, Bifenthrin, Dicofof, Deltamethrin, Pendimethalin, Acephate, Anilofos, Quinalfos, Edinofos. LOD of following pesticides varied from 0.001-0.020mg/Kg. Similarly, the percent recovery of OCs, SPs and Herbicides varies from 70.5-102% from the fortification level of 0.1mg/Kg. The percent recovery of OPs ranged from 74.1-95.54% from the fortification level of 0.1mg/Kg. The pesticide residue recorded below the detection limit was considered as non detectable (ND).

Fruit samples analyzed for the presence of pesticide residues are given in table 3. The level of pesticide residues in various fruits were compared with their MRL fixed by Prevention of Food Adulteration Act (PFA), Govt, of India 1954.

10 different fruit samples were collected from Charkhi Dadri of Haryana during May2015-July2015, out of which in 6 samples, different pesticides were detected. Concentration of pesticides detected in fruit samples is given in table 2. No pesticide was detected in aadu, cheeku (Sapota), muskmelon and mango. None of the pesticides were above MRL. 5 different fruit samples were collected from Jhajjar of Haryana during May2015-July2015. Different pesticides were detected in all of the samples. Profenfos(1.8098mg/kg) was

found above MRL in litchi. 10 different fruit samples were collected from Gurgaon during May15-July2015. Only one sample of banana was contaminated with Aldrin (0.00396mg/kg) and Chlorpyrifos (0.00477). None of the pesticides were above MRL

10 different fruit samples were collected from Charkhi Dadri of Haryana during August2015-October 2015, out of which in 9 samples, different pesticides were detected. No pesticide was detected in muskmelon. Chlorpyrifos(0.944mg/kg) was found above MRL in nashpati. 5 different fruit samples were collected from Jhajjar of Haryana during August2015-October 2015. Different pesticides were detected in all of the samples. None of the pesticides were above MRL. 10 another fruit samples were collected from Gurgaon during August2015-October2015, out of which in 9 samples, different pesticides were detected. None of the pesticides were above MRL. No pesticide was detected in apple.

9 different fruit samples were collected from Charkhi Dadri of Haryana during November2015-January2016, out of which in 7 samples, different pesticides were detected. No pesticide was detected in apple and keenu. None of the pesticides were above MRL. 7 different fruit samples were collected from Jhajjar of Haryana during November2015-January 2016, out of which in 6 samples, different pesticides were detected. No pesticide was detected in grapes. Chlorfenvifos(0.543mg/kg) in keenu and fluvalinate (3.535mg/kg) in mausmi(sweet lime) were found above MRL. 9 another fruit samples were collected from Gurgaon during November2015-January 2016, out of which only in 3 samples (keenu, pomegranate and grapes) different pesticides were detected. Fenvalerate(0.7591mg/kg) in pomegranate was found above MRL

9 different fruit samples were collected from Charkhi Dadri of Haryana during February 2016-April 2016, out of which in 8 samples, different pesticides were detected. No pesticide was detected in guava. Deltamethrin (2.891mg/kg), chlorpyrifos (0.540mg/k) and fluvalinate (1.224mg/kg) in banana were found above MRL. Fluvalinate (1.644mg/kg), alfa-cypermethrin (1.956mg/kg) and phosphomidon(0.5546mg/kg) in pomegranate were found above MRL. Fluvalinate(1.511mg/kg) in grapes, Fluvalinate(3.731mg/kg) in cheeku(sapota) and phorate(0.3020mg/kg) in papaya were found above MRL. So, overall 9 pesticides were found above MRL. 5 different fruit samples were collected from Jhajjar of Haryana during February2016-April 2016. Different pesticides were detected in all of the samples. Phosphomidon(0.2745mg/kg) in banana, Fluvalinate(508733mg/kg), alfa-cypermethrin (1.245mg/kg) in grapes and Fluvalinate(0.8076mg/kg) in orange were found above MRL. 6 another fruit samples were collected from Gurgaon during February2016-April2016. Different pesticides were detected in all of the samples. Bifenthrin (1.563mg/kg) and Fluvalinate(6.477mg/kg) in grapes, Phosphomidon (0.4045mg/kg) in cheeku, Fluvalinate(1.113mg/kg), Fenvalerate(0.8018mg/kg) in apple and Aldrin (0.457mg/kg) in orange were found above MRL.

7 different fruit samples were collected from Charkhi Dadri of Haryana during May2016-July2016. Different pesticides were detected in all of the samples. Phosphomidon(0.3294mg/kg), alfa-cypermethrin(3.215mg/kg) and Deltamethrin(2.1560mg/kg) in muskmelon, phosphomidon(0.2649), alfa-cypermethrin(1.1344mg/kg) and Deltamethrin (1.143mg/kg) in mango were found above MRL. alfa-cypermethrin(1.356mg/kg) in cheeku, alfa-cypermethrin(1.987mg/kg) in mausmi(sweetlime) and alfa-cypermethrin(1.772mg/kg) and Deltamethrin(0.7178mg/kg) in banana were found above MRL. So, overall 10 pesticides were found above MRL.

7 different fruit samples were collected from Jhajjar of Haryana during May2016-July 2016, out of which in 6 samples, different pesticides were detected. No pesticide was detected in guava. Aephate (1.1390) in papaya, phosphomidon (3.64) in nashpati and phosphomidon (1.973) in cheeku (sapota) were found above MRL. Thirty pesticides were detected in fruit samples with range of 0.00172-5.8733 mg/kg. 6 another fruit samples were collected from Gurgaon of Haryana during May2016-July 2016. Different pesticides were detected in all of the samples. Phosphomidon (0.2652mg/kg) in banana, Alfa-Cypermethrin (0.934mg/kg), Phorate(0.1135mg/kg) and Detamethrin (2.731mg/kg) in mango, Alfa-Cypermethrin (1.799mg/kg) in apple and Alfa-Cypermethrin (2.078mg/kg) and Detamethrin (5.859mg/kg) in pomegranate were found above MRL.

7 another fruit samples were collected from Charkhi Dadri during August2016-October2016, out of which in 6 samples, different pesticides were detected. No pesticide was detected in guava. Aephate (1.1390) in

papaya, phosphomidon (3.64) in nashpati and phosphomidon (1.973) in cheeku (sapota) were found above MRL. So, overall 22 pesticides were found above MRL. Thirty pesticides were detected in fruit samples with range of **0.000280--3.731 mg/kg**.

5 another fruit samples were collected from Gurgaon during August 2016-October 2016. Different pesticides were detected in all of the samples. Acephate (1.244mg/kg), Phosphomidon (1.222mg/kg) in apple, Phosphomidon (1.0557mg/kg) in pomegranate and Phosphomidon (1.822mg/kg) in papaya were found above MRL.

9 another fruit samples were collected from Gurgaon during November 2016-December 2016. Different pesticides were detected in all the samples. Phosphomidon (1.8119mg/kg) in keenu, Phosphomidon (0.336mg/kg) in mango, Phosphomidon (1.452mg/kg) in guava, Phosphomidon (1.283mg/kg) in babugosa, Phosphomidon (1.584mg/kg) in pomegranate, Phosphomidon (0.320mg/kg) and Profenfos (0.524mg/kg) in orange were found above MRL. Thirty pesticides were detected in fruit samples with range of 0.00115-6.477mg/kg

Summary of Pesticide Residues Detected in Fruit Sample from Charkhi Dadri, Jhajjar and Gurgaon during May 2015-December 2016 : Total 52 samples from Charkhi Dadri were analysed and found that out of 43 positive samples, 22 samples were found above MRL. Total 29 samples from Jhajjar were analysed and found that out of 27 positive samples, 10 samples were found above MRL. Total 55 samples from Gurgaon were analysed and found that out of 39 positive samples, 25 samples were found above MRL. Total 136 samples were analysed and found that out of 109 positive samples, 57 were found above MRL. (Table 2 & Fig 3; Fig.4).

Table 1 : The percent recoveries, Retention time 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)	R.T
OP Pesticides						
1	Dichlorvos	0.10	85.7	0.003	0.010	5.46
2	Monochrotophos	0.10	95.5	0.02	0.062	9.16
3	Phorate	0.10	90.24	0.010	0.033	9.44
4	Dimethoate	0.10	82.4	0.003	0.01	9.86
5	Diazinon	0.10	74.12	0.001	0.004	10.43
6	Chlorpyrifos- me	0.10	87.67	0.003	0.010	12.44
7	Malaxon	0.10	87	0.002	0.006	12.56
8	Parathion-me	0.10	91.12	0.001	0.003	12.67
9	Malathion	0.10	87.82	0.020	0.061	13.88
10	Chlorpyrifos	0.10	91.02	0.002	0.006	14.25
11	Fenthion	0.10	89	0.003	0.009	14.25
12	Paraxon Me	0.10	83.5	0.002	0.006	11.22
13	Quinalfos	0.10	95.54	0.020	0.062	16.42
14	Chlorfenvifos	0.10	88.21	0.003	0.010	15.95
15	Profenfos	0.10	90.02	0.020	0.061	18.58
16	Ethion	0.10	95.45	0.005	0.016	20.93
17	Triazofos	0.10	89.66	0.001	0.003	21.60
18	Anilofos	0.10	80.0	0.002	0.006	24.15
19	Fenitrothion	0.10	73.52	0.010	0.034	13.61
20	Edinofos	0.10	85.2	0.001	0.003	21.99
21	Parathion	0.10	90.5	0.001	0.003	14.43
22	Phosalone	0.10	90.0	0.003	0.010	25.74

23	Phosphomidon	0.10	87.4	0.004	0.009	12.03
24	Fenamifos	0.10	86.4	0.003	0.010	18.30
OC Pesticides						
1	alpha HCH	0.10	90.02	0.001	0.003	9.63
2	Dialdrin	0.10	94.0	0.002	0.006	25.53
3	o,p DDD	0.10	92.07	0.003	0.010	26.30
4	beta Endosulfan	0.10	96.82	0.001	0.003	29.08
5	o,p DDT	0.10	84.92	0.002	0.007	29.72
6	p,p DDT	0.10	92.52	0.003	0.006	26.29
7	Bifenthrin	0.10	74.2	0.003	0.010	41.7
8	Lamda-Cyhalothrin	0.10	97.14	0.004	0.014	46.63
9	Alpha-Endosulfan	0.10	95.27	0.002	0.006	23.55
10	o,p DDE	0.10	94.12	0.008	0.026	22.91
11	Deltamethrin	0.10	80.08	0.005	0.012	59.20
12	Fluvalinate	0.10	102	0.002	0.007	58.21
13	Alachor	0.10	88.25	0.010	0.030	15.40
14	Aldrin	0.10	84.2	0.001	0.003	18.30
15	Beta- cyhaluthrin	0.10	70.5	0.002	0.006	52.3
16	Beta-HCH	0.10	92.04	0.004	0.014	11.03
17	Delta-HCH	0.10	90.05	0.006	0.020	13.18
18	Dicofol	0.10	82.5	0.003	0.009	10.20
19	Fenpropathrin	0.10	77.5	0.002	0.006	42.7
20	Fenvalerate	0.10	86.74	0.007	0.016	56.84
21	Gama-HCH	0.10	88.82	0.009	0.030	11.44
22	p,p-DDD	0.10	89.5	0.003	0.010	29.4
23	p,p-DDT	0.10	95.2	0.005	0.018	26.294
24	p,p-DDE	0.10	88.58	0.002	0.007	26.06
25	Pendimethalin	0.10	90.34	0.030	0.10	20.82
26	Endosulfone sulfate	0.10	92.26	0.004	0.012	32.55
27	Cypermethrin	0.10	79.23	0.007	0.023	53.03
28	Butachlor	0.10	94.10	0.004	0.014	24.14

Table 2 : Summary of Pesticide Residues Detected in Fruit Sample from Charkhi Dadri, Jhajjar and Gurgaon during May 2015-December 2016

S. NO.	Collection site	Duration	No. Of Samples Drawn	Positive samples	Samples above MRL	Samples with no MRL
1	Dadri	May2015-July2015	10	06	00	01
2	Jhajjar	May2015-July2015	05	05	01	01
3	Gurgaon	May2015-July2015	10	01	00	00
4	Dadri	August2015-October 2015	10	09	00	03
5	Jhajjar	August2015-October 2015	05	05	00	02
6	Gurgaon	August2015-October2015	10	09	00	04
7	Dadri	November2015-January 2016	09	07	00	05
8	Jhajjar	November-January 2016	07	06	02	08
9	Gurgaon	November2015- January 2016	09	03	01	03
10	Dadri	February2016-April 2016	09	08	09	04
11	Jhajjar	February2016-April 2016	05	05	04	03
12	Gurgaon	February2016-April 2016	06	06	06	02
13	Dadri	May2016-July 2016	07	07	10	06
14	Jhajjar	May2016-July 2016	07	06	03	02
15	Gurgaon	May2016-July 2016	06	06	07	04
16	Charkhi Dadri	August2016-October 2016	07	06	03	02
17	Gurgaon	August2016-October 2016	05	05	04	02
18	Gurgaon	November2016-December 2016	09	09	07	02
Total			136	109	57	54

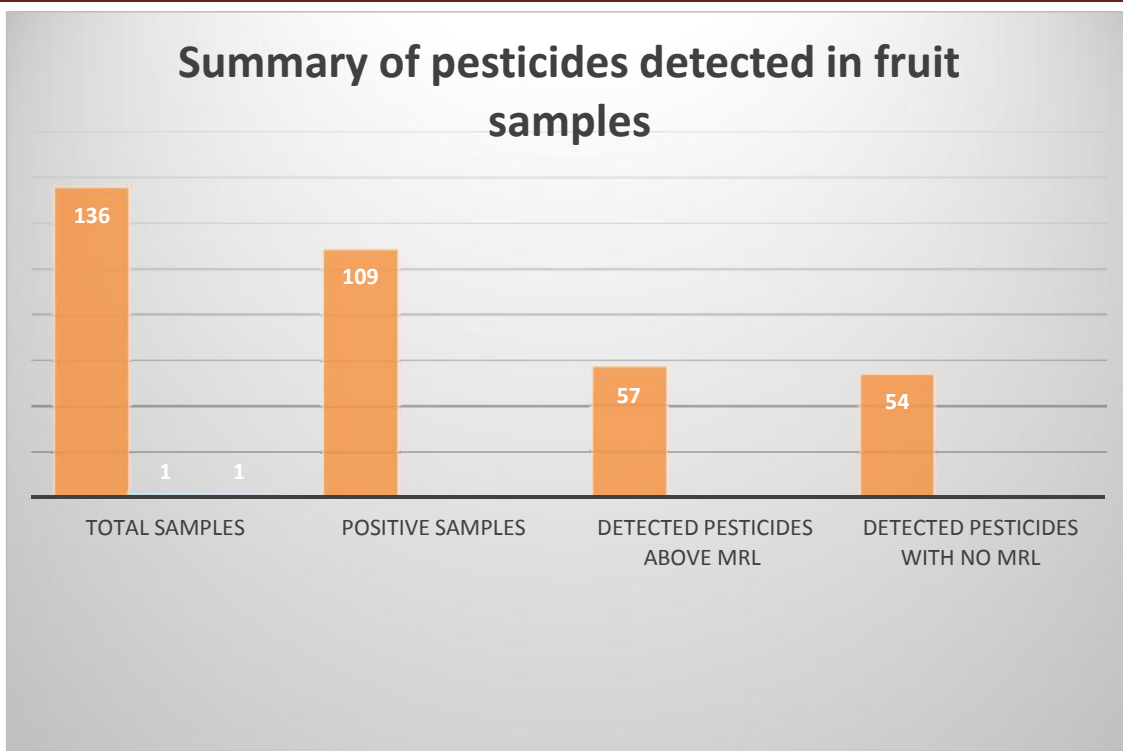


Fig.3: Summary of Pesticide Residues Detected in Fruit Sample from Charkhi Dadri, Jhajjar and Gurgaon during May 2015-December 2016

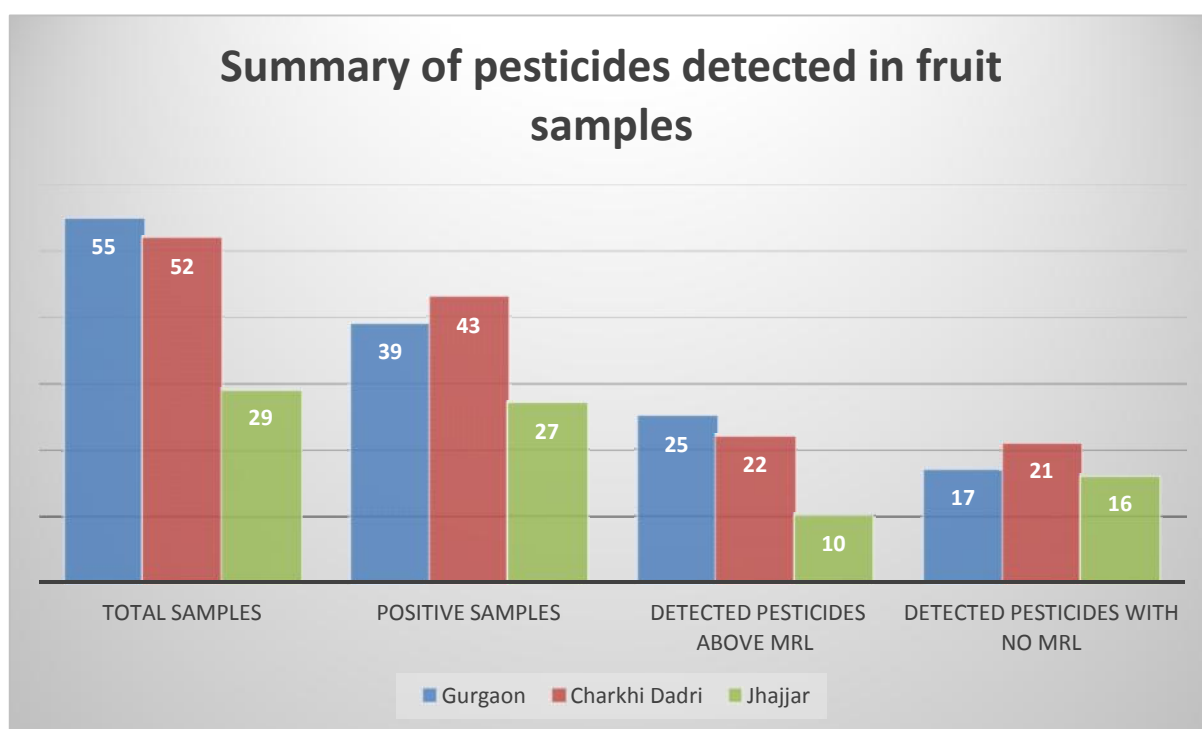


Fig 4: Summary of Pesticide Residues Detected in Fruit Sample from Charkhi Dadri, Jhajjar and Gurgaon during May 2015-December 2016

Table 3: Pesticide residue detected in Fruits collected from different area.

S. N O	Collection site	Duration	Samples Name	Pesticide Name	Concentration			
1.	Dadri	May2015-July2015	Aadu	ND	-			
			Cheeku	ND	-			
			Plum	P,p DDD	0.0252			
				Chlorpyrifos-Me	0.00281			
			Litchi	P,p DDD	0.576			
				Chlorpyrifos-Me	0.0168			
				Quinalfos	0.0151			
			Foot	P,p DDD	0.0453			
				Chlorpyrifos-Me	0.0047			
			Muskmelon	ND	-			
			Mango	ND	-			
			Banana	P,P-DDT	0.830			
				Chlorpyrifos-Me	0.00312			
			Mausmi	P,P-DDT	0.0267			
				Chlorpyrifos	0.080			
Grapes	Aldrin	0.0376						
	P,p DDD	0.0373						
	Chlorpyrifos	0.0257						
2.	Jhajjar	May2015-July 2015	Plum	P,p DDD	0.0258			
			Mango	P,p DDD	0.0447			
				Chlorpyrifos	0.0149			
			Banana	P,p DDD	0.0336			
				Chlorpyrifos	0.0854			
			Litchi	P,p DDD	0.0586			
				Chlorpyrifos	0.0127			
				Profenfos	1.8098			
			Cheeku	Aldrin	0.02066			
				P,p DDD	0.03076			
				Chlorpyrifos	0.0140			
			3.	Gurgaon	May2015-July 2015	Banana	Aldrin	0.00396
Chlorpyrifos	0.0047							
Mausmi	ND	-						
Muskmelon	ND	-						
Cheeku	ND	-						
Litchi	ND	-						
Mango	ND	-						
Khurmani	ND	-						
Plum	ND	-						
Aadu	ND	-						
Foot	ND	-						
4.	Dadri	August2015-October				Cheeku	Gamma-HCH	0.0121

		2015		Chlorpyrifos	0.0036
			Muskmelon	ND	–
			Banana	Gamma-HCH	0.0066
				Parathion	0.00172
			Mausmi	O,p DDT	0.1559
				Endosulfan II	0.0243
				Gamma-HCH	0.0321
				Dicofol	0.0546
			Apple	O,p DDD	0.0231
				Aldrin	0.00295
			Guava	Chlorpyrifos	0.00387
				Gamma-HCH	0.0652
			Papaya	Alfa-Cypermethrin	0.7045
				Fluvalinate	0.1735
				Fenvalerate	0.1981
				Delta- HCH	0.0108
			Nashpati	Chlorpyrifos	0.0043
			Nashpati	Fenvalerate	0.3437
				Gamma-HCH	0.022
				P,p- DDT	0.0470
				Ethion	0.944
			Babugosa	Chlorpyrifos	0.0023
				Gamma-HCH	0.0135
				Deltamethrin	0.1606
			Pomegranate	Chlorpyrifos	0.00208
				Alfa-Cypermethrin	0.268
				Chlorpyrifos	0.031
5.	Jhajjar	August2015-October 2015	Cheeku	Gamma-HCH	0.2580
				Chlorpyrifos	0.0044
			Muskmelon	Gamma-HCH	0.0215
				Chlorpyrifos	0.0503
				Dialdrin	0.0022
			Banana	Gamma-HCH	0.0223
				Delta- HCH	0.0362
				Chlorpyrifos	0.0055
			Mausmi	Endosulfan II	0.0868
				P,p-DDE	0.1458
				Chlorpyrifos	0.0054
			Guava	Gamma-HCH	0.100
				Delta -HCH	0.1517
				Cypermethrin	0.1507
				Fenvalerate	0.1509
				Chlorpyrifos	0.0519
6.	Gurgaon	August2015-October	Cheeku	Gamma-HCH	0.0139

		2015						
			Muskmelon	Chlorpyrifos	0.0333			
				Beta-Cyfluthrin	0.1083			
			Banana	Alfa-Endosulfan	0.0897			
				Chlorpyrifos	0.0064			
			Mausmi	Dicofol	0.415			
				Lamda-Cyhaluthrin	0.315			
				Chlorpyrifos	0.0083			
			Apple	ND	-			
			Guava	Alfa-HCH	0.0110			
				Chlorpyrifos	0.0139			
			Papaya	Fluvalinate	0.223			
			Nashpati	Gamma-HCH	0.0183			
				O,p-DDT	0.0872			
			Babugosa	Gamma-HCH	0.0215			
Pomegranate	Alfa-Cypermethrin	0.0891						
	Chlorpyrifos	0.00388						
7.	Dadri	November15-January 2016	Cheeku	Deltamethrin	0.0498			
				Beta-Cypermethrin	0.0956			
				Alachor	0.0345			
			Banana	O,p-DDT	0.0234			
				Fluvalinate	0.3139			
				Fenvalerate	0.413			
			Mausmi	Gamma-HCH	0.0087			
				Fenvalerate	0.1457			
			Apple	ND	-			
			Guava	Chlorpyrifos	0.00194			
				Alachor	0.0833			
			Papaya	Fluvalinate	0.0936			
				Fenvalerate	0.3151			
			Pomegranate	Dellamethrin	0.0338			
				alfa-Cypermethrin	0.0500			
				Chlorpyrifos	0.0047			
			Keenu	ND	-			
			Grapes	Dicofol	0.04630			
				Chlorpyrifos	0.00028			
			8.	Jhajjar	November15-January 2016	Banana	Aldrin	0.0774
						Mausmi	Aldrin	0.00656
Fluvalinate	3.535							
Bifenthrin	0.463							
Chlorpyrifos	0.0012							
Apple	alfa-Cypermethrin	0.1268						
	Chlorpyrifos	0.00140						

			Guava	Alachor	0.0214
				Pendimethalin	0.00380
				Alfa-Endosulfan	0.00602
				Chlorpyrifos	0.0137
			Pomegranate	Aldrin	0.0475
				Alachor	0.177
				Fenpropathrin	0.120
				Lamda	0.0490
				Cyhaluthrin 1	
				alfa-Cypermethrin	0.0352
				Chlorpyrifos	0.0135
			Keenu	Aldrin	0.0102
				Alachor	0.0746
				Fenvalerate	0.0464
				Chlorfenvifos	0.543
				Edinifos	0.00503
			Grapes	ND	-
9.	Gurgaon	November2015- January 2016	Keenu	Endosulfan-II	0.0032
				Gamma-HCH	0.0044
				Malathion	0.00264
				Edinifos	0.0889
			Mausmi	ND	-
			Apple	ND	-
			Guava	ND	-
			Papaya	ND	-
			Cheeku	ND	-
			Pomegranate	Fenvalerate	0.7591
				Chlorfenvrifos	0.00884
			Banana	ND	-
			Grapes	Fluvalinate	0.3170
				Cypermethrin	0.00115
				Chlorfenvrifos	0.00115
10	Dadri	February16-April 2016	Banana	Deltamethrin	2.891
				Aldrin	0.057
				Chlorpyrifos	0.540
				Ethion	0.08175
				Phorate	0.00575
				Fluvalinate	1.224
			Mausmi	Aldrin	0.0288
				Dialdrin	0.0593
				p,p DDD	0.0301

				Chlorpyrifos	0.1893
				Phorate	0.0176
				Fluvalinate	0.1123
			Apple	alfa-Cypermethrin	0.2308
				Beta-HCH	0.0326
				Phorate	0.00365
			Guava	ND	–
			Pomegranate	Aldrin	0.0165
				Fluvalinate	1.644
				alfa-Cypermethrin	1.956
				Chlorpyrifos	0.1170
				Phorate	0.1754
				Phosphomidon	0.5546
			Keenu	alfa-Cypermethrin	0.434
				Fluvalinate	0.448
				Chlorpyrifos	0.0139
				Phosphomidon	0.03303
				Ethion	0.0330
			Grapes	Aldrin	0.0082
				Fluvalinate	1.5114
				Lamda Cyhaluthrin 1	0.0917
				Chlorpyrifos	0.04407
				Phorate	0.01244
				Ethion	0.1664
			Cheeku	Beta- HCH	0.101
				Fluvalinate	0.1166
				o,p- DDT	0.1020
				Chlorpyrifos	0.0265
				Phorate	0.0112
				Ethion	0.0978
			Papaya	Fluvalinate	3.731
				Phosphomidon	0.2149
				Phorate	0.3020
				Chlorpyrifos	0.0913
11	Jhajjar	February16-April 2016	Banana	Deltamethrin	0.1649
				Chlorpyrifos	0.0148
				Phosphomidon	0.2745
			Apple	Fluvalinate	0.597
				Aldrin	0.0125
				Chlorpyrifos	0.0391
				Phorate	0.00589
				Phosphomidon	0.3464
			Grapes	Fluvalinate	5.8733

				Aldrin	0.0157
				Deltamethrin	0.3871
				alfa-Cypermethrin	1.245
				Ethion	0.0550
				Phorate	0.6397
				Chlorpyrifos	0.0746
			Cheeku	Fluvalinate	0.325
				Aldrin	0.0094
				Deltamethrin	0.1191
				alfa-Cypermethrin	0.687
				Chlorpyrifos	0.0150
			Orange	Fluvalinate	0.8076
				Aldrin	0.0515
				Dialdrin	0.149
				Ethion	0.0594
				Phorate	0.01366
				Chlorpyrifos	0.1360
				Fenvalerate	0.0640
12	Gurgaon	February2016-April 2016	Banana	Aldrin	0.0126
				Chlorfenvifos	0.0708
				Ethion	0.1260
			Apple	Beta-HCH	0.087
				Aldrin	0.036
				Fenvalerate	0.8018
				Fluvalinate	1.113
				Ethion	0.1924
				Chlorpyrifos	0.1290
				Phorate	0.1029
			Orange	Aldrin	0.457
				Pendimethalin	0.457
				P,p-DDD	0.433
				Beta-Cypermethrin	0.736
				Deltamethrin	0.528
				Chlorpyrifos	0.1029
				Ethion	0.2376
			Pomegranate	Aldrin	0.0354
				Fenvalerate	0.2438
				Fluvalinate	0.3106
				Chlorpyrifos	0.2388
				Phorate	0.0508
			Grapes	Aldrin	0.178
				Fluvalinate	6.477
				Dicofol	0.1348
				Bifenthrin	1.563

				Endosulfan sulfate	0.1886
				Chlorpyrifos	0.00857
				Phorate	0.01146
				Phosphomidon	0.2652
			Cheeku	Aldrin	0.095
				Phosphomidon	0.4045
13	Dadri	May2016-July 2016	Banana	Bifenthrin	0.0195
				Fenpropathrin	0.00230
				Deltamethrin	0.7178
				Lamda Cyhaluthrin 1	0.0275
				Lamda Cyhaluthrin 2	0.2238
				alfa-Cypermethrin	1.772
				Chlorpyrifos	0.0323
				Ethion	0.1189
				Mausmi	Bifenthrin
			Fenpropathrin		0.01932
			Deltamethrin		0.4322
			Lamda Cyhaluthrin 1		0.0050
			Lamda Cyhaluthrin 2		0.2847
			alfa-Cypermethrin		1.9872
			Phorate		0.01039
			Ethion		0.2075
			Apple		Bifenthrin
				Fenpropathrin	0.00247
				Deltamethrin	0.5573
				Lamda Cyhaluthrin 1	0.0261
				Lamda Cyhaluthrin 2	0.278
				alfa-Cypermethrin	0.475
				Phorate	0.2178
				Ethion	0.6819
				Pomegranate	P,p- DDT
			Bifenthrin		0.00615
			Fenpropathrin		0.0810
Deltamethrin	0.5428				
Lamda Cyhaluthrin 1	0.00575				
Lamda Cyhaluthrin 2	0.10206				

				alfa-Cypermethrin	0.5513	
				Phorate	0.00263	
				Chlorpyrifos	0.10204	
				Phosphomidon	0.05719	
			Cheeku	Bifenthrin	0.0044	
				Fenpropathrin	0.00376	
				Deltamethrin	0.0519	
				Lamda Cyhaluthrin 1	0.00376	
				Lamda Cyhaluthrin 2	0.207	
				alfa-Cypermethrin	1.356	
				Chlorpyrifos	0.07401	
				Mango	Bifenthrin	0.0009
					Fenpropathrin	0.00293
					Deltamethrin	1.143
			Lamda Cyhaluthrin 1		0.1479	
			Lamda Cyhaluthrin 2		0.2971	
			alfa-Cypermethrin		1.1344	
			Chlorpyrifos		0.3232	
			Ethion		0.08870	
			Phosphomidon		0.2649	
			Muskmelon		Bifenthrin	0.00641
				Fenpropathrin	0.1826	
				Deltamethrin	2.1560	
				Lamda Cyhaluthrin 1	0.0162	
				Lamda Cyhaluthrin 2	0.1020	
				alfa-Cypermethrin	3.215	
				Phosphomidon	0.3294	
				14 Jhajjar May2016–July 2016	Banana	Chlorpyrifos
Anilofos	0.0448					
Apple	Anilofos	0.01354				
	Pomegranate	Ethion	0.00132			
		Parathion	0.0094			
Cheeku	Paraxon-Me	0.0259				
	Phosphomidon	1.973				
Guava	ND	-				

			Nashpati	Chlorpyrifos	0.0376
				Phosphomidon	3.64
			Papaya	Acephate	1.1390
15	Gurgaon	May2016-July 2016	Banana	Bifenthrin	0.0080
				Gamma-HCH	0.00183
				Alfa-Cypermethrin	0.1837
				Fenpropathrin	0.01176
				Lamda-Cyhaluthrin 1	0.0058
				Lamda-Cyhaluthrin 2	0.0409
				Deltamethrin	0.1119
				Phorate	0.00477
				Phosphomidon	0.2652
				Ethion	0.0326
			Mango	Bifenthrin	0.00046
				Alfa-Cypermethrin	0.934
				Fenpropathrin	0.1122
				Lamda-Cyhaluthrin 1	0.0017
				Deltamethrin	2.371
			Apple	Phorate	0.1135
				Phosphomidon	0.10777
				Bifenthrin	0.00183
				Alfa-Cypermethrin	1.799
				Fenpropathrin	0.00213
Lamda-Cyhaluthrin 1	0.0019				
Lamda-Cyhaluthrin 2	0.0400				
Deltamethrin	0.225				
Phorate	0.00477				
Phosphomidon	0.1133				
Apple	Bifenthrin	0.00183			
	Alfa-Cypermethrin	1.799			
	Fenpropathrin	0.00213			
	Lamda-Cyhaluthrin 1	0.0019			
	Lamda-Cyhaluthrin 2	0.0400			
	Lamda-Cyhaluthrin 1	0.0400			

				Cyhaluthrin 2	
				Deltamethrin	0.225
				Phorate	0.00477
				Phosphomidon	0.1133
			Pomegranate	Bifenthrin	0.0112
				Alfa-Cypermethrin	2.078
				Fenpropathrin	0.00070
				Lamda-Cyhaluthrin 1	0.00569
				Lamda-Cyhaluthrin 2	0.0121
				Deltamethrin	5.859
				Chlorpyrifos	0.0846
			Cheeku	Bifenthrin	0.0199
				Alfa-Cypermethrin	0.6994
				Fenpropathrin	0.0911
				Lamda-Cyhaluthrin 1	0.0125
				Lamda-Cyhaluthrin 2	0.0715
				Deltamethrin	0.1933
				Phorate	0.01135
				Phosphomidon	0.1265
				Chlorpyrifos	0.0327
16	Gurgaon	August2016-October2016	Banana	Acephate	0.1987
			Apple	Acephate	1.244
				Phosphomidon	1.222
			Pomegranate	Chlorpyrifos	0.0166
				Phosalone	0.00260
				Phosphomidon	1.0557
			Papaya	Phosphomidon	1.822
			Cheeku	Chlorpyrifos	0.018029
				Phosalone	0.00244
				Acephate	0.05060
17	Gurgaon	November2016-December 2016	Cheeku	Fenthion	0.0123
				Ethion	0.00988
			Keenu	Ethion	0.0029
				Phosphomidon	1.8119
			Mango	Ethion	0.00208
				Phosphomidon	0.336
			Apple	Fenthion	0.0048
				Ethion	0.0021
				Quinalfos	0.0207
			Guava	Fenthion	0.0098

			Ethion	0.0035
			Phosphomidon	1.452
		Babugosa	Phosphomidon	1.283
		Pomegranate	Fenthion	0.0194
			Ethion	0.0043
			Phosphomidon	1.584
		Banana	Ethion	0.00190
		Orange	Ethion	0.0180
			Profenfos	0.524
			Phosphomidon	0.320

CONCLUSION

Most of the fruits analyzed were contaminated with pesticide residues. Pesticides were detected in about 80.147% of the samples collected from different locations but it has been observed that analyzed pesticide residues were above MRL in approximately 41.911% of the fruits samples. Many samples were found contaminated with multi residue. DDT and their isomers, Lindane, Endosulfan, Phosphomidon, Chlorpyrifos, Bifenthrin, lamda-cyhaluthrin, alfa-cypermethrin, deltamethrin, fenvalerate and fluvalinate were detected in many samples. Some of the pesticides like Phosphomidon, Profenfos, Chlorpyrifos, Chlorfenvinfos, fluvalinate, Deltamethrin, Fluvalinate, alfa-cypermethrin phorate, Deltamethrin and Aephate were found above MRL value in some samples. DDD, DDT, Aldrin, ethion, phorate, alachor were found in very low concentrations. Low level of these pesticides in fruits seems to be due to banned or restricted use. Samples collected during August 2015- October 2015 from Charkhi Dadri, Gurgaon and Jhajjar were contaminated with pesticide residues. Samples collected during February 2016-April 2016 & May 2016-July 2016 from Charkhi Dadri, Gurgaon and Jhajjar were found more contaminated than other periods.

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