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Pesticide Content Investigations of Alphonso Mangos

Suhas G. Patil[1], Ravindra Y. Thakur[2],Umesh K. Samant[3]
[1]Department of Chemistry, S. R. M. Mahavidyalaya, Kudal, Sindhudurg, Maharashtra, India
[2]Department of Botany, S. R. M. Mahavidyalaya, Kudal, Sindhudurg, Maharashtra, India
[3]Finolex Academy of Management and Technology, Ratnagiri, Maharashtra, India

ABSTRACT

In the present investigation an attempt has been made to determine the pesticide residues in ripened Alphonso mango fruits samples from Devgad and Vengurle region of the Sindhudurg district, Maharashtra, India. The samples were tested for ninety-eight different pesticides from twenty four chemical groups such as Organochlorines, Organophosphorous, Synthetic Pyrethroids, Triazines, Pyrimidines, Triazoles, Imidazole, Oxazole, Pthalimide, Benzimidazole, Nicotinoids, Aliphatic nitrogen fungicides, Morpholine, Natural product derivatives, Substituted Thiourea, Benzoylphenyl Urea, Strobilurin, Phenyl Pyrazole, Pyrazole, Nitrophenyl Ether, Dithiocarbamates and others. The result shows that almost for all the pesticides, their residue level in the pulp of Alphonso mango is below limit of quantification except Carbendazim which is 0.13 mg/kg but still below MRL i.e. 0.5mg/kg. This shows that pesticides residues in ripened Alphonso mangos from Devgad and Vengurle region are in very traces and are below MRL, therefore the fruits are safe for consumption.

Keywords : MRL, Organochlorines, Organophosphorous, Synthetic Pyrethroids, Triazines, Pyrimidines, Triazoles, Imidazole, Oxazole, Pthalimide, Benzimidazole, Nicotinoids, Aliphatic nitrogen fungicides, Morpholine, Natural product derivatives, Substituted Thiourea, Benzoylphenyl Urea, Strobilurin, Phenyl Pyrazole, Pyrazole, Nitrophenyl Ether, Dithiocarbamates

I. INTRODUCTION

In Maharashtra, Konkan area is very much popular for growing mango, where Alphonso variety is grown prominently. The mango, which has wide varietal differences, grows in longer range of ecogeographical regions. There are different varieties in Konkan with wide range of popularity in common peoples. These varieties are Alphonso, Pairi, Ratna, Mankur, Batalihapus, Narali, Totapuri, Raiwal etc. Out of these mango varieties, Alphonso is very much popular, in the national as well as in the international market because of its aroma and taste.

Economically and nutritionally Alphonso mango is very important. In Sindhudurg district, the area under Alphonso mango cultivation is approximately 27000 hectors
producing 3000 kg mangoes per hector. It plays major role in the economy of Sindhudurg district.

Use of pesticides by cultivators also becomes obligatory to face diseases and pests. To minimize the economic loss caused by the noxious insects, fungi and weeds, farmers rely on pesticides such as, atrazine, cartap, chlorfenvinphos, malathion, methamidophos,

monocrotophos, phosphamidon, etc. (M. Bujagendra Raju et. al. 2011). When applied improperly, residues of some of these pesticides can remain as such and can pose a significant hazard to human health. In India 54 pesticides are regularly monitored in exportable mangoes

The mango fruit is perishable in nature and there are many occasions for it to get spoiled till the fruit reaches to consumer's table. It is estimated that the total loss due to spoilage may be ranging from 30 to 40 per cent. Therefore, the fungicidal dip treatment to the mango fruits is a widely applied practice to increase shelf life of the mango fruits.

Very few mango growers, who export their mangoes, follow good agricultural practices (GAP) to maintain maximum residual limit (MRL). Only exporting mangoes are checked for MRL. Today's market demands not only the quality of agricultural produce but also safety and environment-friendly production practices. Thus, it becomes necessary to check mangoes in local market for MRL of pesticides to find out their safety for consumption.

A number of chemicals are in use today in the production of agricultural commodities. They are essential to modern agriculture. Prevention of health risks, including toxicological risks, due to food intake is central in food safety policy

For most of us the primary source of pesticide exposure is what we eat and drink. Maximum Residue Levels (MRLs) and Acceptable Daily Intake (ADIs) are measures set by government to assure us that the human exposure to pesticides is limited.

But there is no full proof way to ensure a safe universal ADI because of the diversity of food we eat and because some people are more vulnerable than others-especially young children and the malnourished. MRLs and ADIs also do not take into account the effects of combinations of pesticides or pesticide breakdown products.

Despite very low pesticide consumption, Indian food products, mainly fruits and agriculture crops have far more pesticide residue because other countries use degradable pesticides while in India there is more use of persistent pesticides hence their residues remain in food products.

Pesticides are chemical substances used to kill animal, insect, plant and fungal pests in agricultural, domestic and institutional settings. Interest on pesticide toxicity has particularly increased over the past years owing to increasing evidence of carcinogenic, mutagenic and teratogenic effects in experimental animals and exposed humans. They constitute a very important group of chemical compounds that have to be controlled due to their very high toxicity and their widespread use in agricultural practice for field and post-harvest protection. The general population is mainly exposed to pesticides through the ingestion of contaminated foods (such as cereals, vegetables and fruits), which are directly treated with these pesticides or are grown in contaminated fields. Diet is one potentially significant source of pesticide exposure considered in aggregate and cumulative risk models. The organophosphate, organochlorine and related pesticides act by binding to the enzyme acetyl cholinesterase, disrupting nerve function, resulting in paralysis and may cause death. They may produce acute and chronic toxicity. The acute effects manifesting as miosis, urination, diarrhoea, diaphoresis, lacrimation, excitation of CNS and salivation. The chronic exposure involves neurotoxic and behavioural effects. Specific effects of pesticides can include cancer, allergies and hypersensitivities, damage to the central and peripheral nervous systems, reproductive disorders and disruption of the immune system. Recent studies have shown that exposures to contaminants in food may pose a public health risk.

Children may be more susceptible to the effects of these exposures, as they have higher rates of metabolism, less mature immune systems and different patterns of activity and behaviour than adults. Pesticides can also interfere with drug metabolizing enzymes especially Cytochrome P450 leading to drug interactions. .

According to the World Health Organization (WHO, 2003), food consumption consists on averaged for 30% (Based on mass) of fruits and vegetables, and fruits and vegetables are the most frequently consumed food group (WHO, 2003). Fruits and vegetables are essential to a nutritious and healthy diet; however, the health benefits are compromised by consistent contamination with pesticide residues.

At the international level, the Codex Alimentarius Commission of the United Nation's Food and Agriculture Organization and the World Health Organization has established maximum residue limit (MRL) for pesticides in a variety of foods.

II. METHODOLOGY

Pesticide residue analysis was carried out by using GC-MS and LC-Tandem MS techniques.

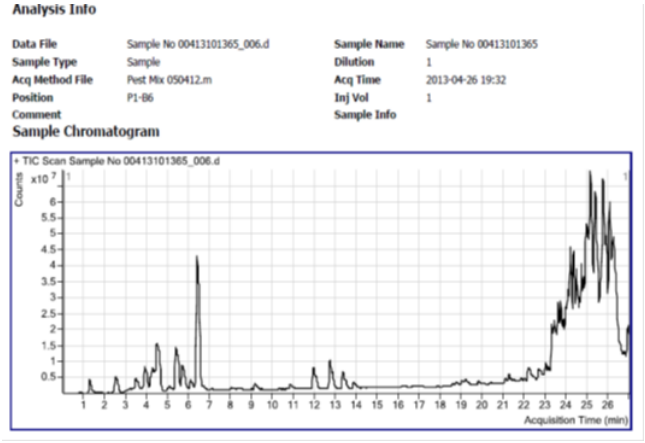
III. EXPERIMENTAL

Ripened Alphonso mango fruits samples were purchased from the local market from Devgad and Vengurle region of the Sindhudurg district. The analysis was carried out from a commercial laboratory 'TUV India Private Limited', Pune. The samples were tested for ninety-eight different pesticides from twenty four chemical groups such as Organochlorines, Organophosphorus, Synthetic Pyrethroids, Triazines, Pyrimidines, Triazoles, Imidazole, Oxazole, Pthalimide, Benzimidazole, Nicotinoids, Aliphatic Nitrogen Fungicides, Morpholine, Natural Product Derivatives, Substituted Thiouria, Benzoylphenyl Urea, Strobilurin, Phenyl Pyrazole, Pyrazole, Nitrophenyl Ether, Dithiocarbamates and others.

IV. RESULTS AND DISCUSSION

Quantitative analysis of Pesticides:

Chromatogram and its Interpretation no. I



Quantitation Results

Compound	RT	Response	Final Conc	
Acephate	3.084	230	0.20	ng/ml
Methomyl	4.121	0	0.00	ng/ml
Simazine	11.232	7862	1.62	ng/ml
Dinotefuran	4.878	2540	1.10	ng/ml
Isoproturon	14.491	52203	1.83	ng/ml
Thiamethoxam	5.783	213	0.04	ng/ml
Fenobucarb	15.380	4158	0.42	ng/ml
Metribuzin	12.005	6331	0.47	ng/ml
Atrazine	13.141	42275	1.91	ng/ml
Monocrotophos	7.084	356	0.04	ng/ml
Dimethoate	8.022	274	0.03	ng/ml
Carboxin	12.417	94668	5.68	ng/ml
Methamidaphos	2.360	223	0.07	ng/ml
Carbofuron	11.100	9	0.00	ng/ml
Forchlorfenuron	14.771	367	0.05	ng/ml
Thacloprid	9.981	4927	0.36	ng/ml
Imidacloprid	7.397	225	0.04	ng/ml
Trichlorfon	7.907	5955	1.74	ng/ml
Demeton-s-methylsulphone	6.722	203	0.01	ng/ml
Flonicamid	15.363	0	0.00	ng/ml
Metalaxyl	14.046	1508	0.06	ng/ml
Penconazole	17.569	299	0.09	ng/ml
Iprobenphos	17.799	640	0.05	ng/ml
Myclobutanil	16.697	1211	0.46	ng/ml
Etrimfos	17.849	529	0.06	ng/ml

Compound	RT	Response	Final Conc	
Tridemorph	18.606	0	0.00	ng/ml
Quinalphos	17.404	761	0.08	ng/ml
Pirimifos-Methyl	18.688	694	0.04	ng/ml
Fenazaquin	22.063	2457	0.10	ng/ml
Tebuconazole	17.980	693	0.22	ng/ml
Ediphenphos	17.783	375	0.02	ng/ml
Fenamidone	16.038	526	0.02	ng/ml
Triazophos	16.483	234	0.01	ng/ml
Kresoxim-methyl	17.602	7385	1.52	ng/ml
Phenthoate	17.470	1412	0.14	ng/ml
Iprovalicarb	16.927	60389	2.90	ng/ml
Pencycuron	17.931	966	0.06	ng/ml
fenarimol	16.910	331	0.24	ng/ml
Propiconazole	17.980	2065	0.51	ng/ml
Thiophenate-methyl	11.923	2342	0.90	ng/ml
Thiodicarb	13.042	307	0.28	ng/ml
Diafenthiuron	20.235	0	0.00	ng/ml
Pyraclostrobin	18.277	27299	1.58	ng/ml
Dimethomorph	16.532	218	0.03	ng/ml
Azoxystrobin	16.038	208	0.01	ng/ml
Difenconazole	18.721	2452	1.00	ng/ml
Trifloxystrobin	18.984	1824	0.09	ng/ml
Mandipropamid	16.104	1653	0.14	ng/ml
Iodosulfuron-Methyl	13.734	1852	2.45	ng/ml
Indoxacarb	19.017	649	0.17	ng/ml
Spinosyn A	19.215	1141	0.07	ng/ml
Emamectin B1b	19.478	0	0.00	ng/ml
Abamactin	22.030	1694	1.36	ng/ml
Emamectin B1a	20.087	3995	0.29	ng/ml
Benomyl	12.071	566	0.25	ng/ml
Carbaryl	12.318	1173	0.33	ng/ml
Carbendazim	7.890	2361714	129.89	ng/ml
Chlorantraniliprole	15.133	1429	0.36	ng/ml
Cyzofamid	17.026	511	0.16	ng/ml
Famoxadone	18.392	503	0.69	ng/ml
Fenpyroximate(E)	20.844	4899	0.27	ng/ml
Flubendamide	17.898	918	0.19	ng/ml
Flufenacet	16.993	214	0.02	ng/ml
Flufenoxuron	20.482	4016	1.13	ng/ml
Flusilazole	17.256	735	0.11	ng/ml
Hexaconazole	17.964	211	0.11	ng/ml
Homobrassinolide	17.174	253	0.24	ng/ml
Lufenuron	20.680	0	0.00	ng/ml
Milbemectin A3	20.927	2	0.07	ng/ml

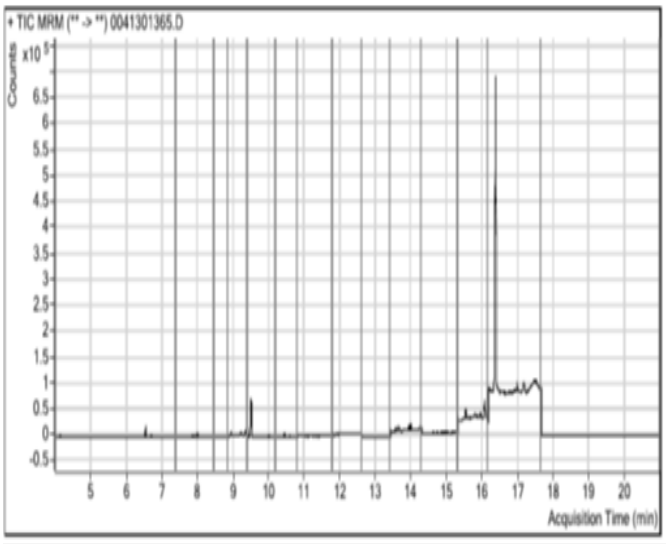
Compound	RT	Response	Final conc.	
Novaluron	19.231	1311	0.89	ng/ml
Omethoate	4.269	260	0.31	ng/ml
Oxadiazon	19.742	242	0.40	ng/ml
Dodine	17.915	17372	0.93	ng/ml
Propragite	21.141	874	0.66	ng/ml
Temephos	19.824	2494	0.55	ng/ml
Paraxon-Methyl	11.265	225	0.12	ng/ml
Paclobutrazole	16.400	1162	0.22	ng/ml

Chromatogram and its Interpretation no. II

Analysis Info

Data File	0041301365.D	Sample Name	0041301365
Sample Type	Sample	Dilution	
Acq Method File	Sea food_Pest_MRM_180413.M	Acq Time	2013-04-26 11:49
Position	124	Inj Vol	3
Comment		Sample Info	

Sample Chromatogram



Quantitation Results:

Compound	RT	Response	Final conc.	
Fipronil	10.794	0	0.00	ng/ml
Heptachlor epoxide	10.677	0	0.00	ng/ml
Butachlor	10.963	0	0.00	ng/ml
cis Chlordane	11.282	0	0.00	ng/ml
Endosulfan alpha	11.105	0	0.00	ng/ml
Isoprothiolane	11.325	0	0.00	ng/ml
o,p- DDE	10.897	0	0.00	ng/ml
Oxyfluorfen	11.627	0	0.00	ng/ml
p,p- DDE	11.428	0	0.00	ng/ml
Profenophos	11.446	0	0.00	ng/ml

Compound	RT	Response	Final Conc	
4-Bromo 2-chlorophenol	5.150	0	0.00	ng/ml
Dichlorvos	4.855	0	0.00	ng/ml
Propoxur	6.944	0	0.00	ng/ml
Trifluralin	7.165	0	0.00	ng/ml
a-HCH	7.675	0	0.00	ng/ml
b HCH	8.166	0	0.00	ng/ml
Diazinon	8.125	0	0.00	ng/ml
Hexachlorobenzene	7.778	0	0.00	ng/ml
Lindane	8.166	0	0.00	ng/ml
Propetamphos	7.963	0	0.00	ng/ml
Chlorothalonil	8.733	0	0.00	ng/ml
d HCH	8.705	0	0.00	ng/ml
Alachlor	9.151	0	0.00	ng/ml
Chlorpyrifos methyl	9.097	0	0.00	ng/ml
Heptachlor	8.902	0	0.00	ng/ml
Parathion-methyl	9.098	0	0.00	ng/ml
Transfluthrin	8.932	0	0.00	ng/ml
Aldrin	9.770	0	0.00	ng/ml
Dicofol	9.956	0	0.00	ng/ml
Fenitrothion	9.576	0	0.00	ng/ml
Malaoxon	9.489	0	0.00	ng/ml
Malathion	9.539	0	0.00	ng/ml
Parathion-ethyl	9.797	0	0.00	ng/ml
Chlorfenvinphos I	10.483	0	0.00	ng/ml
Chlorfenvinphos II	10.281	0	0.00	ng/ml

Compound	RT	Response	Final conc.	
trans Chlordane	10.816	0	0.00	ng/ml
Chlofenapyr	12.004	0	0.00	ng/ml
Endosulfan Beta	12.150	0	0.00	ng/ml
Endrin	12.209	0	0.00	ng/ml
Ethion	12.161	0	0.00	ng/ml
o,p- DDT	12.233	0	0.00	ng/ml
p,p- DDD	12.233	0	0.00	ng/ml
p,p- DDT	12.233	0	0.00	ng/ml
Phorate-sulfone	12.243	0	0.00	ng/ml
Bifenthrin	13.640	0	0.00	ng/ml
Fenpropathrin	13.830	0	0.00	ng/ml
Iprodione	13.730	0	0.00	ng/ml
Lamda _cyhalotrin	14.807	0	0.00	ng/ml
Phosalone	14.679	0	0.00	ng/ml
Pyriproxyfen	14.592	0	0.00	ng/ml
permethrin I	15.581	0	0.00	ng/ml
permethrin II	15.781	0	0.00	ng/ml
Cyfluthrin I	16.353	0	0.00	ng/ml
Cyfluthrin II	16.353	0	0.00	ng/ml
Cyfluthrin III	16.353	0	0.00	ng/ml
Cyfluthrin IV	16.353	0	0.00	ng/ml
Cypermethrin I	16.508	0	0.00	ng/ml
Cypermethrin II	16.975	0	0.00	ng/ml
Cypermethrin III	16.975	0	0.00	ng/ml
Cypermethrin IV	16.975	0	0.00	ng/ml
Ethofenprox	17.150	0	0.00	ng/ml
Deltametrhin	19.458	0	0.00	ng/ml
Tau Fluvalinate I	18.459	0	0.00	ng/ml
Tau Fluvalinate II	18.459	0	0.00	ng/ml

Result Table: (Appendix – I)

Sr. No.	Name of Analyte	Result	Unit	LOQ* (mg/kg)	MRL
I	Organochlorine				
1	Aldrin(expressed as dieldrin)	<LOQ	mg/kg	0.01	0.01
2	Chlordane (cis & trans)	<LOQ	mg/kg	0.01	0.01
3	Chlorothalonil	<LOQ	mg/kg	0.01	0.01
4	DDT (all isomers)	<LOQ	mg/kg	0.01	0.05
5	Dicofol	<LOQ	mg/kg	0.01	0.02
6	Dieldrin (See Aldrin)	<LOQ	mg/kg	0.01	0.01
7	Endosulphan (Alpha and Beta)	<LOQ	mg/kg	0.01	0.05
8	Endrin	<LOQ	mg/kg	0.01	0.01
9	HCH (alpha & beta)	<LOQ	mg/kg	0.01	0.01
10	Heptachlor	<LOQ	mg/kg	0.01	0.01
11	Lindane	<LOQ	mg/kg	0.01	0.01
II	Organophosphorus:-				
12	4-bromo-2-chlorophenol	<LOQ	mg/kg	0.01	NM
13	Acephate	<LOQ	mg/kg	0.01	0.02
14	Chlorfenvinphos	<LOQ	mg/kg	0.01	0.02
15	Chlorpyriphos	<LOQ	mg/kg	0.01	0.05
16	Chlorpyriphos-methyl	<LOQ	mg/kg	0.01	0.05
17	Diazinon	<LOQ	mg/kg	0.01	0.01
18	Dichlorvos	<LOQ	mg/kg	0.01	0.01
19	Dimethoate (Including Omethoate)	<LOQ	mg/kg	0.01	0.02
20	Ethion	<LOQ	mg/kg	0.01	0.01
21	Etrimphos	<LOQ	mg/kg	0.01	NM
22	Fenitrothion	<LOQ	mg/kg	0.01	0.01
23	Iprobenphos	<LOQ	mg/kg	0.01	NM
24	Malathion	<LOQ	mg/kg	0.01	0.02
25	Methamidophos	<LOQ	mg/kg	0.01	0.01
26	Monocrotophos	<LOQ	mg/kg	0.01	NM
27	Omethoate (refer to Dimethoate)	<LOQ	mg/kg	0.01	0.02
28	Oxydemeton-methyl	<LOQ	mg/kg	0.01	0.01
29	Parathion ethyl	<LOQ	mg/kg	0.01	0.05
30	Parathion-methyl	<LOQ	mg/kg	0.01	0.02
31	Phorate	<LOQ	mg/kg	0.01	0.05
32	Phosalone	<LOQ	mg/kg	0.01	0.05
33	Phosphamidon	<LOQ	mg/kg	0.01	0.01
34	Profenophos	<LOQ	mg/kg	0.01	0.2
35	Quinalphos	<LOQ	mg/kg	0.01	0.05
36	Triazophos	<LOQ	mg/kg	0.01	0.01
III	Synthetic Pyrethroids				
37	Cyfluthrin	<LOQ	mg/kg	0.01	0.02

38	Cypermethrin	<LOQ	mg/kg	0.01	0.7
39	Deltamethrin	<LOQ	mg/kg	0.01	0.05
40	Ethofenprox (Etofenprox)	<LOQ	mg/kg	0.01	0.01
41	Fenvalerate & Esfenvalerate (sum of RR & SS isomers)	<LOQ	mg/kg	0.01	0.02
42	Fenvalerate & Esfenvalerate (sum of RS & SR isomers)	<LOQ	mg/kg	0.01	0.02
43	Lambda-cyhalothrin	<LOQ	mg/kg	0.01	0.2
44	Permethrin	<LOQ	mg/kg	0.01	0.05
IV	Triazines				
45	Atrazine	<LOQ	mg/kg	0.01	0.05
46	Simazine	<LOQ	mg/kg	0.01	0.01
V	Acylamino acid fungicides				
47	Metalaxyl & Metalaxyl-M	<LOQ	mg/kg	0.01	0.05
VI	Carbamates				
48	Carbaryl	<LOQ	mg/kg	0.01	0.05
49	Carbofuran	<LOQ	mg/kg	0.01	0.02
50	Carbosulfan	<LOQ	mg/kg	0.01	0.05
51	Indoxacarb	<LOQ	mg/kg	0.01	0.02
52	Iprovalicarb	<LOQ	mg/kg	0.01	0.05
53	Methomyl	<LOQ	mg/kg	0.01	0.02
54	Thiodicarb (See Methomyl)	<LOQ	mg/kg	0.01	0.02
VII	Pyrimidines				
55	Fenarimol	<LOQ	mg/kg	0.01	0.02
VIII	Triazoles				
56	Bitertanol	<LOQ	mg/kg	0.01	0.05
57	Flusilazole	<LOQ	mg/kg	0.01	0.02
58	Hexaconazole	<LOQ	mg/kg	0.01	0.02
59	Myclobutanil	<LOQ	mg/kg	0.01	0.02
60	Penconazole	<LOQ	mg/kg	0.01	0.05
61	Propiconazole	<LOQ	mg/kg	0.01	0.05
62	Tebuconazole	<LOQ	mg/kg	0.01	0.1
63	Triadimefon	<LOQ	mg/kg	0.01	0.1
64	Triadimenol	<LOQ	mg/kg	0.01	
65	Difenoconazole	<LOQ	mg/kg	0.01	0.1
IX	Imidazole				
66	Iprodione	<LOQ	mg/kg	0.01	0.02
67	Fenamidone	<LOQ	mg/kg	0.01	0.02
X	Oxazole				
68	Famoxadone	<LOQ	mg/kg	0.01	0.02
XI	Phthalimide				
69	Captafol	<LOQ	mg/kg	0.01	0.02
70	Captan	<LOQ	mg/kg	0.01	2
XII	Benzimidazole				
71	Carbendazim (Including Benomyl)	0.13	mg/kg	0.01	0.5
72	Thiophanate-methyl	<LOQ	mg/kg	0.01	1
XIII	Nicotinoids				
73	Acetamiprid	<LOQ	mg/kg	0.01	0.01
74	Clothianidin	<LOQ	mg/kg	0.01	0.02
75	Imidacloprid	<LOQ	mg/kg	0.01	0.2
76	Thiacloprid	<LOQ	mg/kg	0.01	0.02
77	Thiamethoxam	<LOQ	mg/kg	0.01	0.5
XIV	Aliphatic Nitrogen fungicides				
78	Cymoxanil	<LOQ	mg/kg	0.01	0.05
XV	Morpholine				
79	Dimethomorph	<LOQ	mg/kg	0.01	0.05
80	Tridemorph	<LOQ	mg/kg	0.01	0.05
XVI	Natural Product Derivative				
81	Buprofezin	<LOQ	mg/kg	0.01	0.1
82	Cartap hydrochloride	<LOQ	mg/kg	0.01	NM
83	Emamectin Benzoate	<LOQ	mg/kg	0.01	0.01
84	Spinosad (Sum of Spinosyn A+D)	<LOQ	mg/kg	0.01	0.02
85	Abamectin	<LOQ	mg/kg	0.01	0.01
XVII	Substituted Thiourea				
86	Difenthiuron	<LOQ	mg/kg	0.01	NM
XVIII	Benzoylphenyl urea				
87	Flufenoxuron	<LOQ	mg/kg	0.01	0.05
XIX	Strobilurin				
88	Azoxystrobin	<LOQ	mg/kg	0.01	0.7
89	Kresoxim methyl	<LOQ	mg/kg	0.01	0.05
90	Pyraclostrobin	<LOQ	mg/kg	0.01	0.05
91	Trifloxystrobin	<LOQ	mg/kg	0.01	0.5
XX	Phenyl pyrazole				
92	Fipronil	<LOQ	mg/kg	0.005	0.005
XXI	Pyrazole				
93	Fenpyroximate	<LOQ	mg/kg	0.01	0.05
XXII	Nitrophenyl ether				
94	Oxyfluorfen	<LOQ	mg/kg	0.01	0.05
XXIII	Others				
95	Propargite	<LOQ	mg/kg	0.01	0.01
96	Diflubenzuron	<LOQ	mg/kg	0.01	0.05
97	Dinocap	<LOQ	mg/kg	0.01	0.05
XIV	Dithiocarbamates				
98	Dithiocarbamates (Mancozeb, Maneb, Propineb, Metiram, Thiram, Zineb and Ziram collectively estimated as CS_2)	<LOQ	mg/kg	0.05	2

The result (Appendix – I) shows that almost for all the pesticides, their residue level in the pulp of Alphonso mango is below limit of quantification except Carbendazim which is 0.13 mg/Kg but still below MRL i.e. 0.5 mg/Kg. This shows that pesticide residues in ripened Alphonso mango pulp from Devgad and Vengurle region are in very traces and are below MRL, therefore the fruits are safe for consumption.

Similar kind of results are noted by different workers. Hussain et.al., (2002) studied different varieties of mango fruits for pesticide residue and found all the samples contaminated but within permissible limits being set by FAO/WHO with reference to public health.

Waskar et.al.,(2004) studied the residue levels of carbendazim and captan in peel and pulp of Kesar mango and found it below detectable limit.

Shah et.al.,(2007) assessed three different varieties of mango for the residues of commonly used pesticides viz Cypermethrin, Methamedophos, Monocrotophos, Cyfluthrin, Dialdrin and Methyl Parathian, and found all the samples to be contaminated with a degree of variation of pesticides residue studied. However, all the samples were within permissible limits, set by FAO/WHO with reference to public health.

Tahir et.al., (2009) analysed some fruits and vegetables for the levels of nine pesticide residues and found that most of the samples did not contain any residues and only two samples had detectable residue but below MRL.

Kumar et.al.,(2010) estimated organochlorine pesticide residues in mango fruits and found below MRL.

Bempah et.al.,(2011) assessed the concentration of pesticide residue in 350 locally produced fruits and vegetables and showed that 37.5% of the fruit and vegetable samples analyzed contained no detectable level of the monitored pesticides, 19.0% of the samples gave results with levels of insecticides residues above the MRL, while 43.5% of the samples showed results below the MRL.

Based on these observations it may be assumed that the Alphonso mango fruits are within the permissible range of MRLs proposed by FAO/WHO and may not pose a serious threat to public health.

But, the various studies disclose that even a low level exposure to pesticide residues puts consumers, especially children on risk in a cumulative manner. So an analysis showing the residues in undetectable or safe range does not essentially mean that it is absolutely safe and free of any untoward effects. More over as mentioned earlier, MRLs and ADIs do not take into account the effects of combinations of pesticides or pesticide Break down products. Besides direct threat to human health, pesticides cause major loss to biodiversity affecting ecosystems. Because most of the pesticides contaminate ecosystems by accumulating in soil and waterbodies. Sindhudurg district is situated on west coast of Maharashtra having great slope from the Sayhyadri range (Western Ghat) to the Arabian see. As a result most of the rain water get mixed to the Arabian see as surface run off. Therefore a large quantity of pesticides sprayed must have get mixed with potable water bodies and see water contaminating marine ecosystem every year, affecting marine life. And most of the population in Sindhudurg is dependent on marine food.

It is studied that, Organochlorine insecticides like DDT accumulate in the food chain because they build up in the fatty tissue of organisms that are then eaten in quantity by higher organisms, thus moving up the food chain and threatening fish, birds and higher animals like humans. Through such an ecological multiplier effect, far away in Antarctica, penguins,

have been found to have enough accumulated pesticides residue to cause their egg shells to be soft and break. There are many examples of even wild life dying or suffering disrupted reproduction because of pesticides used to kill other organisms.

Honey bees, which are vital for successful cropping, are often accidental victims of sprays aimed at harmful insects like grubs and beetles on food crops.

This shows that though there may not be any direct harm to the human being from pesticide residues in fruits and other crops, their indirect effects are also of major concern.

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