

Research Article

Pesticide residues analysis in farm gate vegetables of agricultural areas in Tumakuru district, Karnataka, India

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Article Info

<https://doi.org/10.31018/jans.v13i4.2879>

Received: August 3, 2021

Revised: November 27, 2021

Accepted: December 4, 2021

How to Cite

Shylesha, B.S. *et al.* (2021). Pesticide residues analysis in farm gate vegetables of agricultural areas in Tumakuru district, Karnataka, India. *Journal of Applied and Natural Science*, 13(4), 1437 - 1444. <https://doi.org/10.31018/jans.v13i4.2879>

Abstract

The main purpose of this experiment was to understand pesticide residues persistence and their toxicity level in vegetables. In the present study pesticide residues in tomato (*Solanum lycopersicum*) and capsicum (*Capsicum annuum* L.) vegetables cultivated in Tumakuru, Gubbi, Kunigal and Pavagada taluks in Tumkur district were analysed. In methodology, samples of 1 kg each were collected, cut into small pieces, macerated in a grinder and used for the analysis. Pesticides were quantified by gas chromatography-mass spectrometry (GC-MS). Results showed tomato samples of Pavagada recorded acephate (0.346 mg/kg), dichlorvos (0.189 mg/kg), fenvalerate (0.057 mg/kg) and Tumakuru samples recorded phorate (0.072 mg/kg) residues higher than MRLs (Maximum residue levels). Chlorpyrifos, cyhalothrin-g and cypermethrin were below detection level (BDL) in all the samples. Cyfluthrin- β recorded highest in Kunigal samples (0.294 mg/kg), Tumakuru and Gubbi samples showed BDL. Deltamethrin was highest in Pavagada (0.296 mg/kg) samples and Tumakuru and Kunigal samples revealed BDL. Pavagada samples (0.026 mg/kg) showed monocrotophos residues higher than MRLs. In capsicum samples, acephate residue was highest in Tumakuru samples (0.333 mg/kg), highest chlorpyrifos (0.153 mg/kg) in Kunigal samples, deltamethrin (0.381 mg/kg), fenvalerate (0.168 mg/kg) and phorate (0.089 mg/kg) residues were higher than MRLs in Pavagada samples. Cyfluthrin- β (0.045 mg/kg) was high in Tumakuru and dichlorvos (0.042 mg/kg) high in Pavagada samples. Cyhalothrin-g, cypermethrin and monocrotophos were BDL in all the samples. An attempt has been made to assess the different pesticides usage and their adverse impacts on vegetables, which are backbone to afford assistance for an extensive array of investigators.

Keywords: Capsicum, Farmgate vegetables, Gas chromatography-mass spectrometry, Pesticides, Tomato

INTRODUCTION

Pesticides are widely used throughout the world in agriculture to protect crops. Rampant use of these chemicals has given rise to several adverse effects (Sharma *et al.*, 2019a). Around 51 % of Indian food products are adulterated with pesticide residues and about 20 % of these food products have pesticide residues of maximum residue level (Gill *et al.*, 2020). Low-dose pesticides for elongated duration are progressively more interrelated to human health effects (Wang *et al.*, 2011). Air is polluted due to pesticides and pesticide drift may be seen when the pesticide suspended dust particles are carried by wind to other

areas and contaminating them. Due to pesticide application, the crops may volatilize and be blown into nearby areas that may threaten wildlife. Indian agriculture is largely traditional oriented and pest management is a built-in process but not a separate activity (Sharma *et al.*, 2014; Yadav *et al.*, 2015). India stands next to China in vegetable production and due to inadequate management and residual toxicity, the development of the export market is causing a prime concern. Farmers choose to provide fruits and vegetables to increasingly large numbers of consumers, recognize particular insects, weeds, nematodes, disease-causing organisms and vertebrates as a competitor that may lower the quality

and yield of their produce (Abhilash and Singh, 2009; Schreinemachers and Tipraqsa, 2012; Sharma *et al.*, 2019b). Numbers of pesticides have been registered for use in India against various pests and diseases (Thurman *et al.*, 2008). Pesticides can be broadly classified into insecticide, herbicide, fungicide and others. Another classification based on the chemical composition like organophosphates, organochlorines, synthetic pyrethroids, carbomates, bio-pesticides etc. (Jayaraj *et al.*, 2016). Insecticide use is about 75 % in the country, related to 32 % in the world. Herbicide use only 12 % compared to worldwide ingestion of 47 %. Corbomate and synthetic pyrethroids are together used globally (45 %). Organophosphates constitute 50 % of consumption and bio-pesticides used 1 % compared to 12 % worldwide (Schreinemachers *et al.*, 2015; Yadav *et al.*, 2015; Sharma *et al.*, 2019a). Pesticide is essential for adequate food supply to meet the demand of an increasing population and combat the in borne diseases. Fruits and vegetables are an important part of food intake to meet the balanced diet for humans for a healthy life (Bempah and Donkor, 2011; Kostik *et al.*, 2014; Yilmaz, 2015). Indians are mainly vegetarians thereby, consumption of vegetables in their daily diet is maximum (Beena Kumari *et al.*, 2004). Okra, eggplant, tomato, beans, capsicum and cauliflower vegetables are regularly grown because of sound income with less investment to the farmers. In order to increase the yield, quality and to overcome the incidence of insects and pests, farmers use a disproportionate quantity of pesticides, which leads to the contamination of vegetables with pesticide residues (Indira Devi *et al.*, 2017; Beena Kumari, 2008). To improve the growing demand for fruits and vegetables, farmers utilize pesticides to increase production, preventing pests and diseases which cause problems in vegetable and fruit production (Kumar and Reddy, 2017).

Pesticide residues in fruits and vegetables directly result from applications in the crop growing field and, to a lesser extent, from pesticide residues remaining in the soil. Insecticides still account for 70 % of total pesticide use in India and even if the declining trend in use continues, insecticide residues will likely continue to be an issue for another decade (Directorate of Plant Protection, Quarantine and Storage, 2018; Kolani *et al.*, 2016). The majority of the farmers are ill-informed regarding the nature, dose and application of pesticides and their aftermath effects, as pesticides are very hazardous for organisms and human beings (Shammi *et al.*, 2020). Surplus pesticides were entering into water bodies and also come into agricultural fields through wind affecting various species (Velmurugan *et al.*, 2013). Over time, the repeated application increases pest resistance, while its effects on other species can facilitate the pest's resurgence (Damalas and Eleftherohorinos, 2011). Nevertheless, to the best

of our knowledge, no research on monitoring of pesticides residues have been reported in vegetables Tomato (*Solanum lycopersicum*) and Capsicum (*Capsium annuum* L.) at the field level in four taluks viz., Tumakuru, Gubbi, Kunigal and Pavagada in Tumakuru district of Karnataka State. The present work was aimed to assess the pesticides residues in these two common vegetables and capsicum grown widely in these Taluks.

MATERIALS AND METHODS

Sample collection

Two vegetable samples like tomato (*Solanum lycopersicum*) and capsicum (*Capsium annuum* L.), were collected from the growing areas of Tumakuru, Gubbi, Kunigal and Pavagada taluks in the Tumakuru district (Fig. 1) during 2019. Six samples each of both tomato and capsicum in each taluk were analysed. Samples were collected according to the international standard guideline (Standardization Administration of China, 2008) and evidence regarding pesticide application to vegetable crops was collected from growers during sampling. Samples of 1 kg each were cut into small pieces and macerated in a grinder and used for the analysis (Borgert *et al.*, 2003).

Chemicals

Glass wares used were washed in acetone and dried at 350 °C in an oven. The required solvents such as n-hexane, acetonitrile, petroleum ether and diethyl ether (HPLC grade) were picked up from Sigma Aldrich Co. AR grade Sodium chloride and anhydrous sodium sulphate was bought from Himedia Pvt. Ltd. India. Acetone is used to refine anhydrous sodium sulphate and heated for 4 hrs at 600 °C in a muffle furnace in



Fig. 1. Tumakuru district map showing study areas

order to eradicate phthalate scums. Florosil 60-100 mesh was activated at 350 °C for 5 hrs before use which is procured from Merck India limited. Pesticide values were procured from the Division of Agricultural Chemicals, Indian Agricultural Research Institute, Delhi, India.

Standard preparation

Standard methods suggested by Tekel and Hatrik (1996) were followed to analyse the pesticide residues. An exactly weighed 10 mg of a pesticide was liquefied in 10 ml volumetric flask using n-hexane to make the standard stock solution to 1000 mg kg⁻¹. Standard stock solution of each pesticide was successively diluted to get the sudden lower concentration of 100 mg kg⁻¹. Standard stock pesticide solution was prepared by capturing 0.1 ml solution of compatible (acephate, chlorpyrifos, cyfluthrin-β, cyhalothrin-g, cypermethrin, deltamethrin, dichlorvos (DDVP), fenvalerate, monocrotophos and Phorate) pesticide in a 10 ml volumetric flask, then by using n-hexane volume up to the mark was created and stored in a refrigerator at 5 °C.

Extraction

Pesticides extraction from vegetable samples was done by EPA 3500C method (United States Environmental Protection Agency, 2000) and procedure suggested by Di Muccio *et al.*, (2006). Analytically shred the fresh vegetable samples and homogenized. Around 20 g of sample was softened with 40 ml of ethyl acetate. 5 g of sodium hydrogen carbonate and 20 g of anhydrous sodium sulphate was added to confiscate moisture and then macerated for 3 minutes in Ultra-turrax macerator. Samples were centrifuged for 5 min at 3000 rpm to obtain two phases.

Clean up

Clean-up step was monitored as described by Fardous *et al.* (2007) and Rahman *et al.* (2012) using solid-phase extraction with florisil. The florisil column (500 mg/ 8 ml) cartridge was conditioned with 10 ml ethyl acetate. Pesticides in sample extract (5 ml) were eluted with 10 ml of ethyl acetate; the solutions were concentrated by rotary evaporator to 1 ml and dried by a gentle nitrogen stream, then dissolved in 1 ml of ethyl acetate. Pesticides were then quantified by gas chromatography-mass spectrometry (GC-MS) (Falodun *et al.*, 2009)

Maximum residue limit (MRL)

Pesticide residues of the present experiment were compared with MRL (Table 1) recognised by European Commission (2012) and Food and Agriculture Organization / World Health Organization (2004). MRL is defined as the pesticide residue level existing in the vegetables. According to Environmental Protection

Agency (EPA), MRL is the pesticide residue concentration present in food merchandise. MRL is the maximum pesticide residue concentration expressed in mg/kg recommended by Codex Alimentarius Commission (2017) to be legally permitted in food commodities.

RESULTS AND DISCUSSION

Harmful effects of pesticides

Pesticides cause longer-term health impacts for workers and consumers in addition to acute poisoning from field exposures, even people who live around farms. Chlorpyrifos and other organophosphates are harmful to brain function and are associated with preterm births and neurological disorders among people working on farms and living in agricultural areas. Studies have concluded that pesticide is especially dangerous to children (Mnif *et al.*, 2011; Rauh *et al.*, 2015). Other pesticides, like endocrine disruptors, have been linked to low birth weight, abnormal brain development, increased incidence of cancers and reduced fertility among people. Pesticides were associated with numerous types of cancers, including the brain, pancreatic, lymphoma, myeloma, colon, testicular and soft tissue sarcoma.

Tomato

Tomato (*S. lycopersicum* L.) belongs to the family Solanaceae is commonly grown throughout the globe and typically for the red fruit that is rich in lycopene. Tomato was originated in South America and popularly consumed by a large population in India. There are several diseases that commonly infest tomatoes are various forms of mildew, blight, nematodes and viruses etc. Table 2 describes the pesticide residues in tomato

Table 1. Maximum Residue Limit (MRL) of pesticide residues in vegetables (mg/kg)

Pesticides	MRL (mg/Kg) in Tomato	MRL (mg/Kg) in Capsicum
Acephate	0.02	0.02
Chlorpyrifos	0.5	0.5
Cyfluthrin-β	3.0	2.0
Cyhalothrin-g	0.2	0.2
Cypermethrin	0.2	0.2
Deltamethrin	0.3	0.3
Dichlorvos (DDVP)	0.2	0.2
Fenvalerate	1	0.05
Monocrotophos	NA	NA
Phorate	0.024	0.024

NA: Not available for the vegetables analysed

samples and insecticides standard BDL (Below detection limit) value and range of residues. The results indicated that acephate, cyfluthrin- β , deltamethrin, dichlorvos, fenvalerate, monocrotophos and phorate concentration were higher than MRL (Maximum residue limit) values. Seven out of ten pesticides were detected and chlorpyrifos, cyhalothrin-g and cypermethrin were not shown any accumulation. Although acephate, cyfluthrin- β , deltamethrin, dichlorvos, fenvalerate, monocrotophos and phorate were found, the percentage of contamination varied among the pesticides. Acephate was found highest in Pavagada samples (0.346 mg/kg) followed by Kunigal (0.315 mg/kg), Tumakuru (0.096 mg/kg) and lowest in Gubbi (0.085 mg/kg). Cyfluthrin- β was recorded in Kunigal (0.294 mg/kg) and Pavagada (0.281 mg/kg) samples. Deltamethrin was higher in Pavagada samples (0.296 mg/kg) and low in Gubbi samples (0.231 mg/kg). Dichlorvos was found highest in Pavagada samples (0.189 mg/kg) followed by Kunigal (0.177 mg/kg), Tumakuru (0.013 mg/kg) and lowest in Gubbi (0.011 mg/kg) samples. Fenvalerate concentration was higher in Pavagada samples (0.057 mg/kg) followed by Kunigal (0.041 mg/kg), Gubbi (0.036 mg/kg) and lowest in Tumakuru (0.013 mg/kg) samples. Monocrotophos was found only in Pavagada samples (0.026 mg/kg). Phorate was found in all the four samples and highest in Tumakuru samples (0.072 mg/kg) followed by Pavagada (0.045 mg/kg), Gubbi (0.037 mg/kg) and Kunigal (0.029 mg/kg) samples (Table 2).

The present results are in conformity with the earlier works carried out by Bempah *et al.* (2011) and Li *et al.* (2020). They examined pawpaw, imported apples and tomato samples for organochlorine pesticides and detected several organochlorine pesticide residues. To eradicate aphids in the tomato crop endosulfan was used comprehensively in Ghanian agriculture. Salghi *et al.* (2012) analysed tomato samples from greenhouses in Souss Massa Valley, Morocco and they have detected pesticides in all the samples analysed, three organochlorine pesticides (Dicofol, chlorothalonil and endosulfan) and four pyrethroids pesticides (Bifenithrin, deltamethrin, lambda cyhalothrin and cypermethrin). Acephate pesticides showed the highest residue levels. Irani Mukherjee (2003) identified pesticide residues in seven samples of tomato in and around Delhi, India. All the samples recorded endosulfan, fenvalerate, and acephate in one sample each. Two samples each showed phorate and chlorpyrifos. Maximum pesticides smeared were potent toxins and their rigorous use posed potential hazards to human's livestock and the environment (Ngowi *et al.*, 2007). Sah *et al.*, (2018) reported that cypermethrin and chlorpyrifos residues were above MRL in okra, brinjal and cabbage samples, while endosulfan and quinalphos were found in cauliflower samples in Bihar, India. Nishant and

Upadhyay (2016) observed chlorpyrifos, monocrotophos, endosulfan, DDT and lindane pesticides were observed preliminarily in tomato vegetables in India. From the present study, it was observed that some tomato samples exceeded the MRL. According to farmer's perceptions in the study areas in the Tumakuru district, red spider mites and bollworms were the major pests of tomatoes. There is a considerable increase in red spider mite incidence in all four taluks of Tumakuru district. It may be due to the lack of awareness on pesticides as farmers applied insecticides not recommended for vegetable pest control.

Capsicum

Capsicum (*C. annuum* L.) belongs to the family Solanaceae. Table 3 describes the pesticide residues in capsicum samples and insecticides standard BDL value and range of residues. Results detected seven pesticides viz., acephate, chlorpyrifos, cyfluthrin- β , deltamethrin, dichlorvos, fenvalerate and phorate out of ten pesticides and their concentrations were higher than MRL values and cyhalothrin-g, cypermethrin and monocrotophos were not shown any accumulation. Although acephate, chlorpyrifos, cyfluthrin- β , deltamethrin, dichlorvos, fenvalerate and phorate were found to present in capsicum samples, the percentage of contamination varied from one pesticide to another. Acephate found highest in Tumkur samples (0.333 mg/kg) followed by Kunigal (0.325 mg/kg), Pavagada (0.324 mg/kg) and lowest in Gubbi (0.032 mg/kg). Chlorpyrifos was found highest in Kunigal samples (0.153 mg/kg), Pavagada (0.152 mg/kg), Tumkur samples (0.151 mg/kg) followed by Gubbi (0.015 mg/kg). Cyfluthrin- β was found in Tumkur (0.045 mg/kg) and Pavagada (0.042 mg/kg) samples. Deltamethrin was found high in Pavagada samples (0.381 mg/kg) followed by Tumkur (0.321 mg/kg), Kunigal (0.295 mg/kg) and low in Gubbi samples (0.251 mg/kg). Dichlorvos was found only in Pavagada samples (0.042 mg/kg) and lowest in Tumkur samples (0.041 mg/kg). Fenvalerate concentration is also found high in Pavagada samples (0.168 mg/kg) followed by Tumkur (0.123 mg/kg), Gubbi (0.121 mg/kg) and lowest in Kunigal samples (0.035 mg/kg). Phorate found in all the four sampling places and found highest in Pavagada samples (0.089 mg/kg) followed by Tumkur (0.066 mg/kg), Kunigal (0.057 mg/kg) and lowest in Gubbi (0.046 mg/kg) samples. Capsicum samples analyzed for the pesticide residues revealed that all samples were contaminated with acephate (100 %), chlorpyrifos (100 %), deltamethrin (100 %), fenvalerate (100 %) and phorate (100 %) and two were contaminated with cyfluthrin- β (50 %) and dichlorvos (50 %) (Table 3). Chlorpyrifos level was found below the detection limit in the samples. Golge *et al.* (2018) observed that

Table 2. Pesticide residue values in tomato samples collected in four taluqs of Tumakuru district (mg/kg)

Sl. No.	Pesticides	Tumakuru Taluk (n=6)			Gubbi Taluk (n=6)			Kunigal Taluk (n=6)			Pavagada Taluk (n=6)						
		a(b)	Min	Max	Mean	a(b)	Min	Max	Mean	a(b)	Min	Max	Mean	a(b)	Min	Max	Mean
1	Acephate	3(50)	0.043	0.149	0.096	4(66.6)	0.049	0.121	0.085	3(50)	0.252	0.378	0.315	4(66.6)	0.226	0.466	0.346
2	Chlorpyrifos	3(50)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL
3	Cyfluthrin-β	2(33.3)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL	2(33.3)	0.116	0.472	0.294	3(50)	146	416	0.281
4	Cyhalothrin-g	3(50)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL
5	Cypermethrin	2(33.3)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL
6	Deltamethrin	3(50)	BDL	BDL	BDL	2(33.3)	0.144	0.318	0.231	2(33.3)	BDL	BDL	BDL	2(33.3)	0.233	0.359	0.296
7	Dichlorvos (DDVP)	3(50)	0.008	0.018	0.013	2(33.3)	0.004	0.018	0.011	2(33.3)	0.117	0.230	0.177	2(33.3)	0.112	0.266	0.189
8	Fenvalerate	3(50)	0.011	0.015	0.013	2(33.3)	0.024	0.048	0.036	3(50)	0.012	0.070	0.041	3(50)	0.032	0.082	0.057
9	Monocrotophos	2(33.3)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL	3(50)	0.016	0.036	0.026
10	Phorate	4(66.6)	0.061	0.083	0.072	3(50)	0.021	0.053	0.037	3(50)	0.011	0.047	0.029	2(33.3)	0.022	0.054	0.045

BDL= Below detection limit, n = No. of samples analysed, a = Contaminated, b = % of contamination

Table 3. Pesticide residue values in capsicum samples collected in four taluqs of Tumakuru district (mg/kg)

Sl. No.	Pesticides	Tumakuru Taluk (n=6)			Gubbi Taluk (n=6)			Kunigal Taluk (n=6)			Pavagada Taluk (n=6)						
		a(b)	Min	Max	Mean	a(b)	Min	Max	Mean	a(b)	Min	Max	Mean	a(b)	Min	Max	Mean
1	Acephate	3(50)	0.216	0.450	0.333	4(66.6)	0.16	0.048	0.032	3(50)	0.255	0.395	0.325	4(66.6)	0.254	0.394	0.324
2	Chlorpyrifos	3(50)	0.096	0.206	0.151	2(33.3)	0.07	0.023	0.015	3(50)	0.112	0.194	0.153	3(50)	0.086	0.218	0.152
3	Cyfluthrin-β	2(33.3)	0.014	0.076	0.045	3(50)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL	3(50)	0.032	0.052	0.042
4	Cyhalothrin-g	3(50)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL
5	Cypermethrin	2(33.3)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL
6	Deltamethrin	3(50)	0.175	0.467	0.321	3(50)	0.110	0.391	0.251	2(33.3)	0.179	0.411	0.295	3(50)	0.282	0.480	0.381
7	Dichlorvos (DDVP)	3(50)	0.033	0.049	0.041	2(33.3)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL	2(33.3)	0.033	0.051	0.042
8	Fenvalerate	3(50)	0.056	0.190	0.123	2(33.3)	0.051	0.191	0.121	3(50)	0.019	0.051	0.035	4(66.6)	0.108	0.220	0.168
9	Monocrotophos	3(50)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL	2(33.3)	BDL	BDL	BDL	3(50)	BDL	BDL	BDL
10	Phorate	2(33.3)	0.034	0.098	0.066	3(50)	0.041	0.052	0.046	3(50)	0.046	0.068	0.057	4(66.6)	0.052	0.126	0.089

BDL= Below detection limit, n = No. of samples analysed, a = Contaminated, b = % of contamination

propamocarb and chlorpyrifos were mainly responsible for vulnerabilities manifestation in green pepper and cucumber. Loughlin *et al.* (2018) reported that insecticide chlorpyrifos was in maximum frequency in vegetables and fruits tested. Pesticides like chlorpyrifos, monocrotophos, endosulfan, DDT and lindane were observed preliminarily in most of the vegetables and okra, brinjal, lettuce, cucumber and tomato vegetables were exceedingly adulterated by pesticides in India (Nishant and Upadhyay, 2016). Swarnam and Velmurugan (2013) experimented on vegetable samples like brinjal, okra, chilli, crucifers and cucurbits for the presence of organochlorines (OC), organophosphorus (OP) and synthetic pyrethroid (SP) compounds; and observed that 34 % of the samples tested had pesticide residues. Owago *et al.* (2009) observed organochlorine pesticides in vegetables from Deyang and Yanting areas of the Chengdu economic region, Sichuan province, China. They reported endosulfan contamination in a few capsicum samples is high because pests are active in vegetables grown with a high concentration of OCPs. During summer, high temperature volatilized OCPs from soil or vegetation and therefore vegetables secreted evaporating pesticides. Subhash Chandra *et al.* (2010) determined pesticide residues of Cypermethrin and Chlorpyrifos in vegetables (capsicum and brinjal) purchased from local markets by GC-ECD. Tapped Recoveries of these residues are over 90 %, with a coefficient of variation below 5 %. The LOD of chlorpyrifos and cypermethrin were 0.005 mg/kg and LOQ was 0.02 mg/kg. Growers used pesticides to stun bacterial and fungal diseases in capsicum crops. Singh and Gupta (2002) reported that pesticides are commonly detected in capsicum. Chlorpropham was most frequently used and detected in capsicum. They also observed that Azoxystrobin is used as a fungicide to control plant diseases in various crops, including potatoes. All samples were below the Canadian MRL of 30 mg kg⁻¹. Quintero *et al.* (2008) reported that capsicum was contaminated with OCPs metamidophos (31.3 %). Zhu *et al.* (2014) reported that capsicum samples showed fenitrothion and malathion insecticides with the mean concentration of 31.0 and 28.6 ppb, respectively. No chlorinated insecticide or nitrogen-containing halogenated fungicides were detected.

Conclusion

The pesticide residue analysis on two vegetables (Tomato and Capsicum) using GC-ECD did not indicate the presence of pesticide residues in almost all the samples examined. The only handful of samples showed their presence. There are many reasons for the accumulation of pesticides in fruits and vegetables.

Farmers have been spraying the pesticide to combat pests and diseases and increase the yield of the crop for several years. Protracted use of pesticides will encourage pest confrontation every time when high amounts are applied. The present study provides favourable evidence on pesticide residue pollution in tomato and capsicum vegetables that helps protect the obstructed environment in the Tumakuru district. Further study on a greater measure should be conducted on vegetables to regulate the pesticide residues condition.

Conflict of interest

The authors declare that they have no conflict of interest.

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