ORIGINAL ARTICLE

Survey on Pesticides Used by Farmers in Belagavi Taluka and Analysis of Pesticide Residues in Commonly Used Vegetables

Moitri Majumdar[1], Madhav Prabhu[2], Sanjay Mishra[3], Mubashir Angolkar[1]*

[1]Department of Public Health, [2]Department of General Medicine,[3]Dr. Prabhakar Kore Basic Science Research Center, KLE Academy of Higher Education and Research, Belagavi -590010 (Karnataka) India

Abstract

Background: Fruits and vegetables are important components of the human diet since they provide essential nutrients that are required for most of the reactions occurring in the body. However, indiscriminate and overuse of pesticides damage agriculture and environment, but the pesticide residues on food products affect the health. *Aim and Objective:* The present study aimed to assess the Knowledge, Attitude and Practices (KAP) among the farmers of Belagavi taluka, regarding the pesticide use and to determine pesticide residues in commonly used vegetables. *Materials and Methods:* The present cross-sectional study included a total of 200 farmers selected randomly from 4 divisions of Belagavi taluka. Questionnaire was developed to assess the KAP. Fresh tomatoes and chilies were used as samples, fine homogenized sample (200 g) was extracted with ethyl acetate and analyzed using gas chromatography-mass spectrometry. *Results:* Most of them were aware of the precautions to be taken during pesticide use. However, not all farmers followed the measures. Maximum of them used pesticides (n=150), followed recommended method (n=130) and concentration (n=152). Pesticide residues found in chili and tomato samples exceeded the maximum residue limit. *Conclusion:* Chlorpyrifos and ethion in tomato sample, and chlorpyrifos and cypermethrin in chillies sample were the pesticide residues. Protective measures followed by the farmers was poor. Therefore, the knowledge of the farmers should be upgraded and, camps should be conducted periodically to monitor pesticide residues and health of the farmers.

Keywords: Belgaum Farmers, Pesticides, Vegetables, Knowledge, Attitude and Practice

Introduction:

Pesticides are widely used in the agricultural practice to control pests, diseases, weeds, and other plant pathogens to ensure high agriculture productivity [1-2]. Easy application, rapid action, and low production of toxins by the food-infecting organisms have increased the use of pesticides than other pest control methods [3]. In India, the utilization of pesticides in agriculture has gradually increased since 1950-51 [4]. However, indiscriminate and overuse of pesticides may spoil the health of both farmers and general consumers. In addition, the applied pesticides and their degradation products or metabolites remain as residues on vegetables and fruits potentially causing health disorders [1].

Health-related concerns with pesticides range from short-term impacts such as nausea, headaches, skin, and respiratory problems to chronic impacts such as birth defects, endocrine disruption, neurological problems, infertility, and various cancers [5]. Previous studies reported that inadequate knowledge, lack of information and training on pesticide safety, inappropriate spraying practices, and inadequate personal protection during pesticide use are the contributing factors for morbidity and mortality

among farmers [6]. In addition, pesticides contribute to biodiversity losses, deterioration of natural habitats and environmental pollution [7].

Numerous techniques have been developed for the analysis of pesticide residues in vegetables, which include Gas Chromatography (GC) and Liquid Chromatography (LC) coupled to Mass Spectrometry (GC; GC-MS, LC-MS) and tandem mass spectrometry (GC-MS/MS, LC-MS/MS), and further on. However, GC coupled with MS is the widely used technology due to its high selectivity towards the nonpolar compounds [8].

Many researchers in different countries and different regions around the world assessed the farmer's Knowledge, Attitude and Practices (KAP) regarding pesticide use [6, 9-10]. Also, many studies were conducted to screen the residue of pesticides and their metabolites in the commonly used vegetables and fruits [1, 3, 11]. However, to the best of our knowledge, no study has been conducted in Belgavi, Karnataka; therefore, the current study was undertaken. Moreover, understanding farmer's knowledge, safety practices, and attitude towards the use of pesticides is important to provide information for reducing the health risks as well as environmental risks associated with the pesticides. The present study was thus aimed to assess the KAP among the farmers of Belagavi taluka, Karnataka regarding the pesticide use and their residues in commonly used vegetables and fruits.

Material and Methods:

Sampling and study design

A cross-sectional study was conducted for one and half year (September 2014-January 2016) in four divisions of Belagavi taluka, Karnataka namely, Belagavi, Bagewadi, Kakati, and Uchagaon. From each division five villages were selected randomly and from each village 10 farmers were selected randomly. Altogether, a total of 200 farmers were selected for the study. Multistage random sampling method was used to select the villages, farms, and farmers. Farmers involved in farming for more than 1 year and using pesticides in their farms in the selected regions of Belagavi taluka were selected for the study. While farmers who were not willing to participate were excluded from the study. Ethical clearance was obtained from Institutional Ethics Committee and written informed consent was obtained from the eligible farmers.

Data Collection

The farmers were interviewed using predesigned and pretested questionnaire (Supplementary Material 1) to record the sociodemographic and socioeconomic status (categorized according to B.G. Prasad's classification) [12] pesticide use and practices, applicator precautions/averting behavior, and health/environment effects. KAP regarding pesticide use, economic expenditure, wages, and awareness on scheme provided by the government. Collected data were analyzed using SPSS 20.0. Descriptive data were analyzed using percentage and proportion

Gas Chromatography-Mass Spectrometry (GC-MS)

Sample collection and preparation

Fresh tomatoes and chilies weighing 1 kg and 250 g, respectively, were randomly collected for the study. All the samples were collected using gloves, packed in sterilized plastic bags, transported to the laboratory, and stored at -20°C in refrigerator until analysis, to avoid degradation between sampling and analysis. The samples were chopped into tiny pieces and mixed thoroughly. A portion of the chopped sample weighing 200 g

was blended in a high-speed blender to obtain a fine homogenized representative sample.

Sample extraction and clean-up

An aliquot (25 g) of the fine homogenized sample was added in a 250-ml Erlenmeyer flask along with 37-ml ethyl acetate and 12-g anhydrous sodium sulfate, which were shaken in a horizontal shaker (Orbital shaking incubator) for 2 h at the speed of 220 cycles/min. The ethyl acetate extract was filtered through Whatman (No. 4) filter paper. After cleaning, the extracts were collected in a 100-ml round-bottom flask and were concentrated in a rotary evaporator. The extract was evaporated to dryness under a stream of nitrogen and then was dissolved in exactly 5 ml of methanol. Extracts were filtered using 0.2 μm filter paper before conducting the chromatographic analysis.

GC-MS/MS analysis

Samples prepared as per analysis procedure were submitted for GC-MS/MS acquisition to NABL Accredited Laboratory 'Center for Food Testing, Pune, Maharashtra. A Varian 3800 gas chromatograph coupled with a Saturn 2200 mass spectrometer with auto-injector CP-8410 were used for the analysis. The mass spectrometer was auto-turned using perfluorotributylamine. Helium (99.999%) at a flowrate of 1 ml/min was used as a carrier and collision gas at 9.6 psi pressure. Sample injection (1 μL) was done in split-less mode, with an injector temperature of 280°C. The computer that controlled the system also held a GC-MS library, specially created for the target analysts under the experimental conditions. The mass spectrometer was calibrated weekly with perfluorotributylamine.

Data acquisition was carried out by GC-MS software and data interpretation and quantification were carried out by using Mass Hunter software (Agilent Technologies, USA). Samples were analyzed in multiple-reaction monitoring modes in GC-MS/MS. Results of individual pesticides were compared with multilevel calibration of pesticide standards ranging between 0.01 PPM and 0.2 PPM.

Results:

Characteristics of the study respondents

Table 1 shows sociodemographic characteristics of study respondents. More than three-fourths of the study respondents were men (n = 173) aged between 36–45 years (n = 82). Most of the farmers completed primary education (n = 97), were married (n = 143), living in a joint family (n = 123), belonging to socioeconomic class IV status (n = 175), and owed open agricultural fields (n = 155). Most of the farmers gained knowledge from pesticide sellers (n = 66) and ministry of agriculture (n = 64).

Table 1: Sociodemographic Data of the Respondents

Variables		n	Percent
Gender	Female	27	13.5
	Male	173	86.5
Age (years)	⩽25	8	4.0
	26-35	68	34.0
	36-45	82	41.0
	46-55	42	21.0
Literacy	Illiterate`	19	7.5
	Primary	97	48.5
	High school	8	4.0
	Higher Secondary	76	38

Continued...

Variables		n	Percent
Marital status:	Married	143	71.5
	Single	15	7.5
	Widowed	32	16.0
	Divorced	10	5.0
Type of family:	Nuclear	31	15.5
	Joint	123	61.5
	Broken	28	14.0
	Extended	18	9.0
Socioeconomic status:	Class I	0	0
	Class II	0	0
	Class III	25	12.5
	Class IV	175	87.5
	Class V	0	0
	Open	155	77.5
	Closed	7	3.5
	Mixed	38	19.0
	By experience	23	1.5
	Product label	12	6.0
	From a specialist	35	17.5
	From a pesticide seller	66	33.0
	Ministry of agriculture	64	32.0

Knowledge, attitude, and practice regarding pesticide use

Knowledge

The response of farmers towards the knowledge of pesticide use is as given in Table 2. All the respondents had knowledge about pesticide and majority (n = 145) knew about the pesticides they used. Only one-fourth (n = 57) of the respondents were aware of other ways of pest control, however most (n = 171) of them knew about the impact of the pesticide on human health. The majority were aware that pesticides enter the body through the skin (n = 191) and causes skin rashes (n = 197) followed by skin irritation/itching (n = 195). Most of them had lack of knowledge regarding the pesticides that were banned, guidelines for pesticide use, and pesticides accepted internationally. All the farmers (n = 200) had knowledge regarding the use of gloves during pesticide use. The majority did not know about any toxicological or medical center (n = 90) and the eKutir scheme (n = 106) launched by the government.

Attitude

The response of farmers towards the attitude of pesticide use is as given in Table 3. Almost, 172 respondents thought pesticides are necessary to prevent diseases. More than half (n = 107) of the respondents followed instructions of labels on the pesticide bottles. Nearly three-fourths (n = 134) of the respondents believed that pesticides enter the vegetables and fruits that they grow. Almost, 110 and 143 respondents have updated information on pesticide and schemes launched by the government, respectively. Most of the respondents never ate, drank, and smoked during the pesticide use. Most (n = 159) of the respondents washed their hands after pesticide application.

Table 2: Response of Farmers towards the Knowledge Questionnaire

Knowledge question	Yes, n (%)	No, n (%)	Don't know, n (%)
Do you know what a pesticide is?	200 (100.0)	0	0
Do you know the name of the pesticides you use?	145 (72.5)	55 (27.5)	0
Do you know any other ways for pest control rather than pesticide use?	57 (28.5)	143 (71.5)	0
Does exposure to the pesticide have an adverse health effect or impact on the human health?	171 (85.5)	9 (4.5)	20 (10.0)
According to your knowledge, do the adverse health effects of the pesticides include the following on the consumers?			
Headache/Migraine	182 (91.0)	5 (2.5)	13 (6.5)
Watering/Sore eyes	135 (67.5)	28 (14.0)	37 (18.5)
Cough/Cold/Chest pain/Breathlessness	55 (27.5)	90 (45.0)	55 (27.5)
Dizziness	122 (61.0)	48 (24.0)	30 (15.0)
Weakness	174 (87.0)	13 (6.5)	13 (6.5)
Burning sensation in eyes/on face	192 (96.0)	7 (3.5)	1 (0.5)
Skin rash	197 (98.5)	3 (1.5)	0
Itching/Skin irritation	195 (97.5)	3 (1.5)	2 (1.0)
Salivation/Nausea/Vomiting	36 (18.0)	84 (42.0)	80 (40.0)
Abdominal pain/Diarrhea	19 (9.5)	97 (48.5)	84 (42.0)
Fever/Rise in temperature	20 (10.0)	108 (54.0)	72 (36.0)
Forgetfulness	14 (7.0)	110 (55.0)	76 (38.0)
Do all the pesticides have the same adverse health effects on the human health?	46 (23.0)	68 (34.0)	86 (43.0)
Do pesticides enter human body through the following?			
Inhalation	60 (30.0)	44 (22.0)	96 (48.0)
Skin	191 (95.5)	2 (1.0)	7 (3.5)

Continued...

Knowledge question	Yes, n (%)	No, n (%)	Don't know, n (%)
Which organs are affected by pesticides?			
Lungs	59 (29.5)	141 (70.5)	0
Eyes	191 (95.5)	9 (4.5)	0
Skin	190 (95.0)	10 (5.0)	0
Do pesticides remain after using it in the following?			
In Air	39 (19.5)	40 (20.0)	121 (60.5)
Soil	98 (49.0)	32 (16.0)	70 (35.0)
Ground water	122 (61.0)	24 (12.0)	54 (27.0)
Fruits, seeds, and leaves of vegetables and fruits	169 (84.5)	9 (4.5)	22 (11.0)
Do you know if any pesticides are banned?	35 (17.5)	68 (34.0)	97 (48.5)
Do you know if any guidelines regarding pesticide use in India?	0	96 (48.0)	104 (52.0)
Do you know how much amount of pesticides is accepted internationally?	0	99 (49.5)	101 (50.5)
Which of the following do you think can protect farm workers from the harmful effects of pesticides?			
Wearing gloves	200 (100.0)	0	0
Using goggles	198 (99.0)	2 (1.0)	0
Wearing wide brimmed hat	147 (73.5)	38 (19.0)	15 (7.5)
Putting on nasal masks	200 (100.0)	0	0
Wearing special boots	183 (91.5)	11 (5.5)	6 (3.0)
Eye mask	197 (98.5)	2 (1.0)	1 (0.5)
Face mask	198 (99.0)	1 (0.5)	1 (0.5)
Special cloths	106 (54.0)	58 (29.0)	36 (18.0)
Do you know if there is any toxicological or medical center in your area, which provides medical services to farm workers?	68(34.0)	42 (21.0)	90 (45.0)
Are you aware of eKutir scheme launched by the government?	38 (19.0)	56 (28.0)	106 (53.0)

Table 3: Response of Farmers towards Attitude Questionnaire

Attitude question	Always, n (%)	Sometimes, n (%)	Never, n (%)
Are pesticides necessary to prevent the vegetables and fruits from diseases?	172 (86.0)	27 (13.5)	1 (0.5)
Is it necessary to follow instructions of labels on pesticide bottles?	107 (53.5)	91 (45.5)	2 (11.0)
Can pesticides enter vegetables and fruits that you grow?	56 (28.0)	134 (67.0)	10 (5.0)
Do pesticides harm those who eat it?	62 (31.0)	132 (66.0)	6 (3.0)
Do pesticides are harmful to the health?	73 (36.5)	123 (61.5)	4 (2.0)
Is it necessary to stay updated with information on pesticide	80 (40.0)	110 (55)	10 (5.0)
Is scheme launched by government are useful?	23 (11.5)	143 (71.5)	34 (17.0)
Is washing hands after application useful?	159 (79.5)	41 (20.5)	0
Do you think that whether you should do the following during pesticide application?			
Eating	1 (0.5)	9 (4.5)	190 (95.0)
Drinking	1 (0.5)	23 (11.5)	176 (88.0)
Smoking	3 (1.5)	52 (26.0)	145 (72.5)

Practice

The response of farmers towards the practice of pesticide use is as given in Table 4. Nearly half (n = 95) of the respondents practiced pesticide use for > 5 years. Only one respondent worked with pesticides for > 6 hours per day. Nearly three-fourth (n = 130) of the patients followed the instructions on the pesticide bottle. Occasionally, about 126 respondents sprayed two or more mixed pesticides at a time. Almost, 152 respondents used the pesticides in the recommended concentration while only two respondents used more than the recommended concentration. Most (n = 156) of them stored empty pesticide bottles or cans in a specific area in the farm site. Almost, 147 respondents prepared pesticides in the field. The empty pesticide bottle was buried or burnt after use by most of the respondents (n = 128). Most of them sprayed pesticides by wearing gloves (n = 185), goggles (n = 184), and face mask (n = 174). Almost, three-fourths (n = 158) showered after spraying. Only 13 respondents entered the field after spraying pesticide. Only 27 respondents placed first aid kit in the farm. Most of them (n = 156) had never participated in seminars or training courses related to the health impact and use of pesticides. Nearly three-fourths (n = 136) committed to the safety period. Almost, 144 respondents suffered from skin rashes; most of them (n = 182) consulted a doctor on exposure to pesticides.

Table 4: Response of Farmers towards Practice Questionnaire

Practice	Always, n (%)	Sometimes, n (%)	Never, n (%)
Do you use pesticide?	150 (75.0)	50 (25.0)	0
Do you follow the instructions of label on the pesticide bottles?	130 (75.0)	67 (33.6)	3 (1.5)
Do you spray two or more mixed pesticides?	6 (3.0)	126 (63.0)	68 (34.0)
The concentration of pesticides you use are?			
The recommended	152 (76.0)	46 (23.0)	2 (1.0)
More than the recommended	2 (1.0)	137 (68.5)	61 (30.5)
Less than the recommended	0	134 (67.0)	66 (33.0)
Not committed with the specific concentration	2 (1.0)	67 (33.5)	131(60.5)
Where do you store empty pesticide bottles or cans?			
In the specific farm site	156 (78.0)	43 (22.5)	1 (0.5)
At home	3 (1.5)	141 (71.5)	56 (28.5)
What are the pesticide preparation places?			
Home kitchen	13 (6.5)	138 (69.0)	49 (28.5)
Home garden	19 (9.5)	153 (76.5)	28 (14.0)
The field	147 (73.5)	48 (24.0)	5 (2.5)
What are you doing with the empty pesticide bottles or cans?			
For the home uses (storage water)	21 (10.5)	140 (70.0)	39 (19.5)
For the home uses (storage food stuff)	22 (11.0)	137 (67.5)	41 (20.5)
For storing other pesticide types	26 (13)	136 (68.0)	38 (19.0)
For burying and burning	128 (64.0)	66 (33.0)	6 (3.0)
Do you apply pesticide by spraying?	166 (83.0)	33 (16.5)	1 (0.5)

Continued...

Practice	Always, n (%)	Sometimes, n (%)	Never, n (%)
Which of the following do you practice during preparing or spraying of pesticides?			
Gloves	185 (92.5)	12 (6.0)	3 (1.5)
Goggles	184 (92.0)	10 (5.0)	6 (3.0)
Face mask	174 (87.0)	25 (12.5)	1 (0.5)
Special shoes	42 (21.0)	94 (47.0)	64 (32.0)
Do you take shower after spraying?	158 (79.0)	42 (21.0)	0
Do you keep any first aid in the farm?	27 (13.5)	137 (68.5)	36 (18.0)
Participation in seminars or training courses related to the health impact and minimizing use of pesticide.	3 (1.5)	41 (20.5)	156 (78.0)
Do you commit to the safety period?	136 (68.0)	63 (31.5)	1 (0.5)
Do you suffer from any of the following symptoms?			
Skin rash	144 (72.0)	55 (27.5)	1 (0.5)
Headache	134 (67.0)	65 (32.5)	1 (0.5)
Excessive sweating	14 (7.0)	127 (63.5)	59 (29.5)
Redness of skin	85 (42.5)	102 (51.0)	13 (6.5)
Abdominal pain	0	98 (49.0)	102 (51.0)
Itching of eyes	99 (49.5)	85 (42.5)	16 (8.0)
Vomiting	0	58 (29.0)	142 (71.0)
Shortness of breath	3 (1.5)	106 (53.0)	91 (45.5)
Muscle cramps	15 (7.5)	160 (80.0)	25 (12.5)
What are the actions taken if anybody becomes sick following exposure to pesticides?			
Patient taken to health center	21 (10.5)	163 (81.5)	16 (8.0)
Consult local doctor	182 (91.0)	18 (9.0)	0
Patient taken to Panchayat Pradhan	0	89 (44.5)	111 (55.5)

Economic expenditure on pesticides and usage of government services

Most of the respondents (n = 194) spent out-of-pocket on pesticide purchase. Almost 194 respondents purchased pesticides based on the cost of pesticide. Nearly three-fourths (n = 156) were unaware of the services provided by the government or private sectors. Only 32 respondents used the services offered by the government more frequently.

Analysis of pesticide residues in commonly used vegetables

Pesticides detected in analyzed samples comprised of chlorpyrifos, cypermethrin, dichlorvos, ethion, bifenthrin, lambda-cyhalothrin, and endosulphan (Supplementary material 2). Chillli sample contained residues of chlorpyrifos [Maximum Residue Limit (MRL) value = 0.05 mg/kg] and ethion (MRL value = 0.3 mg/kg) are above MRL value i.e. 1.668 mg/kg and 7.094 mg/kg, respectively. Bifenthrin (MRL value = 0.5 mg/kg), Dichlorvos (MRL value = 0.1 mg/kg) and lambda-cyhalothrin (MRL value = 0.5 mg/kg) are below MRL value i.e. 0.01 mg/kg, 0.012 mg/kg, and 0.147 mg/kg, respectively. Tomato sample contained residues of chlorpyrifos and cypermethrin (MRL value = 0.03 mg/kg) above MRL value i.e. 1.668 mg/kg and 1.96 mg/kg, respectively, and residues of bifenthrin, lambda-cyhalothrin and endosulfan (MRL value = 0.5 mg/kg) are below MRL value i.e. 0.06 mg/kg, 0.02 mg/kg, and 0.06 mg/kg, respectively.

Discussion:

Studies have reported that farmers had misconceived notions concerning the pesticide use [13]. Therefore, the survey was conducted to determine the KAP among the farmers of Belagavi taluka, Karnataka towards pesticide use and analysis of their residues in commonly used vegetables.

Sociodemographic characteristics found in the present study are comparable to other studies in the literature. A study conducted among 200 farmers in Gaza trip reported that majority were men (81%) aged between 40 and 53 years (36%), and 31.2% possessed open agricultural fields [9]. A study conducted in Thailand among 330 farmers showed majority were men (53%) aged between 31 and 50 years; 71.2% completed primary education, and 87.9 % were married [13]. Source of information regarding pesticide use in this study is similar to other studies [13-14], wherein they attained maximum knowledge from different sources such as agricultural officers, television, articles, and salespersons.

The overall response of farmers towards the questionnaire was high, indicating their wholesome participation in the study. Knowledge about the names of the pesticides used was high, while knowledge about other ways of pest control (natural, biological, and agricultural ways of pest control) was relatively low. This demands to launch an extension of educational programs on pesticide substitutes among farmers of Belagavi taluka. A high proportion of farmers were aware of dermal absorption of pesticides than other routes, this is in agreement with other similar researches [15]. Farmers had moderate knowledge regarding the fate of pesticides in air, groundwater, soil, seeds, leafy vegetables, and fruits, which might affect the farmers when they get in contact with these after spraying.

Many were aware of the adverse effects of pesticides on human health, however, few of them did not follow the precautions unless they were aware of the measures. The reason for negligence

might be due to the carelessness, cost, discomfort, or unavailability of protective measures [9]. This is quite similar to studies conducted in different countries [9, 16]. Consistent with another study, low proportion of farmers placed pesticides at home [10], nevertheless, this might also pose as a potential risk for children and adults at home [6]. Improper use or disposal of empty containers of pesticides might lead to pesticide toxicity in humans, animals, and the environment [17]. However, in our study, many of the farmers discarded empty pesticide containers in a proper way. In contrast, other studies [6, 18] reported that farmers disposed empty containers in streets and used empty containers for different purposes. Farmers believed that taking shower might remove contaminants from body surfaces after preparing/spraying pesticides [9], which is comparable to our study.

Consistent with other studies [7, 9, 19] the use of mixed pesticides was quite high among the farmers. The synergistic effect of different chemicals in the pesticides may result in toxicity among farmers [9]. Although pesticides used in the study were within the recommended concentration, nearly three-fourths of the farmers used higher concentrations than recommended. This also might be one of the reasons for toxicity symptoms reported by the farmers.

In our study, farmers had lack of knowledge regarding pesticides banned, guidelines followed during pesticide use, amount of pesticide accepted internationally, medical or toxicological centers and schemes launched by the government. The practice of maintaining first-aid kits, attending seminars or training courses to upgrade the knowledge regarding pesticide use, and actions taken on exposure to pesticides were not implemented in this region. Hence, an extension of the programs regarding the pesticide management and regulation, public awareness, and reinforcement of safety should be implemented to educate the farmers [10].

Long-term consumption of pesticide-contaminated foods, even at moderate levels, deposits in the tissues and shows a negative impact on the human health [20]. Although many harmful pesticides such as organochlorine pesticides are banned in many countries, these residues are still found in vegetables and fruits [21-22]. Hence, in our study, the presence of synthetic pesticide residues in the tomato and chilli samples were tested. Synthetic pesticides under many classes, including organochlorine, organophosphorus, pyrethroids, acylamino acid fungicide, triazoles, phthalimide, substituted thioureas, strobilurin, and phenyl pyrazole were analyzed. Chlorpyrifos and ethion in the chilli sample and chlorpyrifos and cypermethrin in the tomato sample contained pesticide residues above the recommended MRL values. In Kuwait, residues of cypermethrin exceeded the MRL values in the tomato sample [1]. In Lahore, pesticide residues were absent in 83% of vegetable samples analyzed, whereas 50% of the tomato samples analyzed had detectable residue levels [11]. In Bangalore, chlorpyrifos and quinalphos contamination was absent in the tomato samples [23]. A study conducted in Haveri district, Karnataka reported, pesticide residues (acetamiprid, thiodicarb, flubendiamide, mancozeb, carbosulfan and spinosad) with exceeded MRL values in 11 out of 30 chilli samples analyzed using Ultra-performance liquid chromatography [24].

The present study has noteworthy limitations. The adverse health effects reported by the farmers

might be like symptoms of other diseases, therefore, the farmers' medical history should be recorded, to avoid the bias. As the pesticide residues were detected in single sample, studies in more samples in these vegetables are needed to authenticate the current discoveries.

Conclusion:

Farmers in the Belagavi taluka widely used pesticides. Chlorpyrifos and ethion in tomato sample, and chlorpyrifos and cypermethrin in chilli sample were the pesticide residues exceeded the MRL. Protective measures followed by the farmers, during pesticide use, was poor. Farmers were unaware of the pesticides banned, guidelines of pesticide use, toxicological centers, and schemes launched by the government. Therefore, knowledge of the farmers should be upgraded regarding alternative measures of pest control. Also, camps should be conducted periodically to monitor pesticide residues and health of the farmers.

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[*] ***Author for Correspondence:*** *Dr. Madhav Prabhu, Department of General Medicine, KLE Academy of Higher Education and Research, Belagavi -590010 Email: maddy2380@gmail.com Cell: 09738462380*