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Detection of synthetic pesticide residues prevalent in daily consuming salad vegetables sold in the local markets of Rajshahi City, Bangladesh

Ismat Moin Tamanna [1,*], Md. Badrul Islam [2], G.M Masud Rana [3], Sarmina Yeasmin [3] and Tahmina Akter Chowdhury [3]

[1] *Department of Genetic Engineering and Biotechnology, University of Rajshahi, Rajshahi, Bangladesh.*
[2] *Natural Products Research Division, Bangladesh Council of Scientific and Industrial Research (BCSIR), Rajshahi, Bangladesh.*
[3] *Oil, Fats and Waxes Research Division, Bangladesh Council of Scientific and Industrial Research (BCSIR), Rajshahi, Bangladesh.*

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Abstract

Fresh salad vegetables have become a convenient part of daily diet of people nowadays because of their nutritional enrichment. Although raw vegetables are compact source of high nutritional values, these vegetables are sometimes detrimental to human health because of being potential route of human exposure to pesticide contaminants. This study is focused on the prevalence of pesticide contaminants in daily consuming common salad vegetables. The study was conducted to observe six pesticides residue (Cypermethrin, Mancozeb, Malathion, Rovral, Imazalil, Endrin) using gas chromatography mass spectrometry (GC-MS) in five types of raw consuming vegetables that are sold in the local markets of Rajshahi City. The findings suggest that almost all the vegetables of three markets were contamination free. The residual level of all six targeted pesticides had not been detected. Thus, this study suggests that the application of pesticides in the fields of Rajshahi City is within safe limit.

Keywords: Pesticide residues; Cypermethrin; Vegetables; Contamination

1. Introduction

Synthetic pesticide residues pose threat to human health. Both short term and long-term toxic effects that are hazardous to health can be caused by exposure to chemical and pesticide residues, especially when it is used in high level. These health risks include headaches, nausea, irritation, vomiting, abdominal pain etc. Several studies have demonstrated that vegetables absorb pesticides internally when they are sprayed on them and cause adverse effects when consumed by humans and animals [1,2]. The rate of vegetable production in Bangladesh has been increased and this rate is higher than the previous decade. Since the production has been increased, the application of pesticides has been increased as well [3]. In Bangladesh the use of pesticide is uncontrolled. Approximately 80 types of pesticides are being used in fields indiscriminately by the farmers in Bangladesh without having awareness of hazardous effects of pesticides on human health [4,5]. Previous report suggests that Bangladeshi people are in high health risk of organophosphate pesticide residues as the residues remain in vegetables and enter into human body when these vegetables are consumed raw [6]. In addition, with pesticides, vegetables are also being contaminated with many natural microcontaminants (NMCs). Vegetables that are cultivated in periurban area are exposed to atmospheric and water pollution [7]. Air pollution caused by transportation infrastructures such as airport, vehicles, highways and the use of reclaimed and polluted water bearing natural micro contaminants (NMCs) that is being used in irrigation are the main source of gathering of these NMCs and trace factors in ground and lastly into greens [8,9]. Again, the biosolids and compost that are being used for

* Corresponding author: Ismat Moin Tamanna

soil amendment have been reported as the main cause of agricultural exposure to organic microcontaminants (OMC) [10]. In present world climate change and population increase has become main reason to the water scarcity and the usage of reclaimed water for irrigation in periurban agriculture has come to be a primary choice for water supply [11] which is making these land contaminated with OMCs. It has been observed that the OMCs are bioaccumulated in plants grown underneath field situation irrigated with treated water [12]. The edible part of leafy veggies accumulates these OMCs in higher concentration for example in roots or fruits [13]. Excessive level of pesticide application results in the absorption of these pesticides into soil and leads to the accumulation of residues in the edible parts of vegetables. Sometimes these pesticide residues are mixed with rain water and meet water bodies. Use of waste water that is polluted with industrial activities for irrigation is the most important cause of contamination of food crops cultivated in the land [14,15,16]. The major health risk associated with the consumption of these food crops is the exposure to agrochemical residues and trace elements [17]. Besides these the usage of reclaimed water in agriculture has another detrimental impact which is the high nitrate content in reclaimed water [7]. Even though veggies contain some amount of nitrate which is the main human dietary supplement of nitrate but 5 % of the ingested nitrate is converted into poisonous configuration of nitrate [18]. Using treated waste water and nitrate fertilization can avail to nitrate elevation through food vegetation [19]. There is scarcity of knowledge on the bioaccumulation of OMCs in veggies that are cultivated with treated waste water [20]. The observation of a long-term study has revealed that irrigation with waste water for longer duration may lead to significant amount of bioaccumulation and uptake of OMCs [21]. In one hand vegetables are being subjected to high level of pesticide application which is directly absorbed into vegetables; on the other hand, these vegetables are also accumulating micro contaminants in their edible parts. As a result, vegetables are being a major route of human exposure to toxic residues. All these issues demonstrated above leads to the conclusion that enough research should be carried out on market vegetables that are consumed raw and fresh. However, in Bangladesh only few research reports are available on prevalence of pesticide residues in salad vegetables that are available in local markets and in case of Rajshahi city the reports are the least, although they are consumed daily by the common people. Therefore, the present study was aimed to focus on the prevalence of pesticide residues on salad vegetables that are sold daily in Rajshahi city local markets.

2. Materials and Methods

2.1. Sample collection and preservation

According to protocol samples were collected with standard carrying tools. Food graded poly bags were used during sample collection. A total 60 samples including 5 carrots (*Daucus carota*), 5 cucumbers (*Cucumis sativus*), 5 tomatoes (*Solanum lycopersicum*), 5 bundle of coriander leaves (*Coriandrum sativum*) and 500 gm of green chili (*Capsicum frutescens*) were collected from three different markets (Binodpur Bazar, Katakhali Bazar and Shaheb Bazar) of Rajshahi city, Bangladesh. Approximately 500gm weight of each sample was used for residual analysis. After reaching to laboratory the samples were stored at 2-8 ^{o}C temperature throughout the analysis. Sample collection plan is presented in Table 1.

Table 1 Sample collection plan

Serial No.	Name of sampling site	Name of Samples	Weight of sample (gm)	Storage Condition ^{o}C
1	Binodpur Bazar	Cucumber, Carrot, Coriander leaf, Tomato, Green chili	500	2-8
2	Katakhali Bazar	Cucumber, Carrot, Coriander leaf, Tomato, Green chili	500	2-8
3	Shaheb Bazar	Cucumber, Carrot, Coriander leaf, Tomato, Green chili	500	2-8

2.2. Sample preparation for GC-MS analysis

A quick, easy, cheap, effective, rugged and safe (QuEChERS) method was followed to prepare the sample with acetate buffering (AOAC Official Method 2007.01). The samples were homogenized with house- hold mill and in a 50 ml falcon tube 15gm of sample was weighted. 100 ml of 50mg triphenyl phosphate (TPP) surrogate standard solution in acetonitrile was added in addition with 15 ml acetonitrile with 1% acetic acid solution. Then 2.5gm sodium acetate trihydrate and 6gm MgSO4 were added and with vortex the sample was mixed well. The sample was then centrifuged at 5000 rpm for 5 minutes. An Eppendorf tube containing 750mg MgSO4 and 250 mg PSA and then 5ml of supernatant

was transferred to it. The extract was shaken using a vortex mixture. Then centrifuged at 10000 rpm for 5 minutes. The supernatant of 3 ml was filtered through a 0.45 mm filter and 800ml portions were transferred to an autosample vials. The extracts were evaporated to dryness and reconstituted in 800 ml acetonitrile/water (20/80. v/v) for the Gas Chromatography-Mass Spectrometry (GC-MS) analysis.

2.3. GC-MS Analysis

GC-MS analysis of the respective samples was carried out by GCMS-QP2010 (Shimadzu Corporation, Japan). The chromatography method was carried out by capillary column that is characterized by 30m in length and 0.25 mm in inner diameter. The column is prepared by 5% diphenyl and 95% dimethyl poly-siloxane. Injection temperature was set at 220^{o}C. Initially the oven temperature was set at 80^{0}C and it remained isothermal for 2 minutes, then programmed to 150^{0}C at the rate of 5^{0}C/min and finally held at 280^{0}C. The ion source temperature was 280^{0}C. Helium was used as a carrier gas with the flow rate of 1.72 ml/min. 4 micro-liter of the sample was injected in the split-less mode in the ratio of 1:100. For GC-MS detection, the ionizing energy gained by the detector was 45 m/z. A scan interval of 0.30 second. The prepared sample was then run for 50 min to complete GC/MS analysis. All peaks obtained were compared with the GC–MS library database (NIST library 2008 and 2014 edition).

3. Result and Discussion

The study was aimed to identify six types of commonly used pesticides in five different types of vegetables that are consumed raw. Pesticides were classified as pyrethroid, thiocarbamate, organophosphate, imidazole and organochlorine based on their chemical groups (Table 2)

Table 2 Types and chemical groups of selected pesticides

Pesticide	Type	Chemical group
Cypermethrin	Insecticide	Pyrethroid
Mancozeb	Fungicide	Thiocarbamate
Malathion	Insecticide	Organophosphate
Rovral	Fungicide	-----
Imazalil	Fungicide	Imidazole
Endrin	Insecticide	Organochlorine

Total 20 samples along with 500gm of green chili were collected from Katakhali bazar and analyzed for pesticide residues. The result showed that all the samples of Katakhali bazar were free of Cypermethrin, Mancozeb, Malathion, Rovral, Imazalil and Endrin (Table 3). Although none of the targeted pesticides were ~~not~~ found in Cucumber, Coriander leaf and Tomato samples of Binodpur bazar but presence of Endrin was confirmed in carrot samples and the concentration was below detection level (Table 4). Other 20 vegetables that were collected from the markets of Shaheb bazaar showed no trace of pesticide residues (Table 5)

Table 3 Concentration of pesticide residues in selected vegetables of Katakhali Bazar

Pesticide	Carrot	Cucumber	Coriander leaf	Tomato	Green Chili
Cypermethrin	ND	ND	ND	ND	ND
Mancozeb	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND
Rovral	ND	ND	ND	ND	ND
Imazalil	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND

Table 4 Concentration of pesticide residues in selected vegetables of Binodpur Bazar

Pesticide	Carrot	Cucumber	Coriander leaf	Tomato	Green Chili
Cypermethrin	ND	ND	ND	ND	ND
Mancozeb	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND
Rovral	ND	ND	ND	ND	ND
Imazalil	ND	ND	ND	ND	ND
Endrin	BDL	ND	ND	ND	ND

Table 5 Concentration of pesticide residues in selected vegetables of Shaheb Bazar

Pesticide	Carrot	Cucumber	Coriander leaf	Tomato	Green Chili
Cypermethrin	ND	ND	ND	ND	ND
Mancozeb	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND
Rovral	ND	ND	ND	ND	ND
Imazalil	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND

Here ND= Not Detected, BDL= Below Detection Level

Since the study was conducted on three major markets of Rajshahi city where vegetables are supplied from different regions of Rajshahi division, the result suggest that application of pesticides in the agricultural lands of these regions are within acceptable range. This study result can be compared to another research work conducted in the markets of Rangpur City where research was conducted on cauliflower and tomato samples. The result showed that in case of cauliflower, 85% samples showed no pesticide contamination and in case of tomato samples, 87% samples contained no pesticide [22]. Another research work performed in the markets of Dhaka City where the result showed that out of all four samples only coriander leaf was contaminated with Dimethoate [23].

3.1. Possible cause of pesticide contamination of vegetables

Consumption of pesticide contaminated vegetables can be the cause of carcinogenic, oncogenic, genotoxic effect on human health [24]. One possible reason of pesticide contamination of vegetables can be the increased growth of population. With the rapid growth of population, the demand of food supply is increasing day by day. As a result, to fulfill the growing demand of food and to make available food supply in the markets farmers are trying to grow more and more food crops and vegetables within short period of time. As a result, they are choosing pesticides and chemical fertilizers to grow their crops within short period of time. This results in absorption of the residuals in the edible parts of plants leading to the entry of these pesticide residues into food chain. The final outcome is the exposure of human being to these pesticide residues by consuming such contaminated foods. The aim of this study was to confirm whether the people of Rajshahi city are having safe or contaminated raw vegetables. Since almost all the samples showed no trace of pesticide residues, it can be concluded that farmers are either using minimum level of pesticides or they are not using pesticides at all to cultivate the vegetables.

4. Conclusion

Although the present finding suggests that the vegetables that are being produced in Rajshahi city are free of pesticides, this scenario can be altered if the pesticide application practices in the fields go unchecked. Regular monitoring of farmers' pesticide application methods throughout the growing of vegetables is mandatory as well as appropriate instruction on excessive risks and safe insecticide use are also crucial. Our findings may also serve as a basis for the national regulatory authority to implement the necessary steps regarding this issue.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that this research work has no conflict of interest.

References

[1] Ahmed, A., Randhawa, M. A., Yusuf, M. J., & Khalid, N. (2011). Effect of processing on pesticide residues in food crops: a review. *Journal of Agricultural Research, 49*(3), 379-390.

[2] Thanki, N., Joshi, P., & Joshi, H. (2012). Effect of household processing on reduction of pesticide residues in Bringal (Eggplant, Solanum melongena). *Advances in Applied Science Research, 3*(5), 2860-2865.

[3] Khatun, P., Islam, A., Sachi, S., Islam, M. Z., & Islam, P. (2023). Pesticides in vegetable production in Bangladesh: A systemic review of contamination levels and associated health risks in the last decade. *Toxicology Reports, 11*, 199-211.

[4] Alam, M. N., Chowdhury, M., Hossain, M. S., Mijanur Rahman, M., Rahman, M. A., Gan, S. H., & Khalil, M. I. (2015). Detection of residual levels and associated health risk of seven pesticides in fresh eggplant and tomato samples from Narayanganj District, Bangladesh. *Journal of Chemistry*, 2015.

[5] Chowdhury, M. T. I., Razzaque, M. A., & Khan, M. S. I. (2011). Chlorinated pesticide residue status in tomato, potato and carrot. *Journal of Experimental Sciences, 2*(1).

[6] Rahman, M., Hoque, M. S., Bhowmik, S., Ferdousi, S., Kabiraz, M. P., & van Brakel, M. L. (2021). Monitoring of pesticide residues from fish feed, fish and vegetables in Bangladesh by GC-MS using the QuEChERS method. *Heliyon, 7*(3).

[7] Hurtado, C., Parastar, H., Matamoros, V., Piña, B., Tauler, R., & Bayona, J. M. (2017). Linking the morphological and metabolomic response of Lactuca sativa L exposed to emerging contaminants using GC× GC-MS and chemometric tools. *Scientific reports, 7*(1), 6546.

[8] Colon, B., & Toor, G. S. (2016). A review of uptake and translocation of pharmaceuticals and personal care products by food crops irrigated with treated wastewater. *Advances in agronomy, 140*, 75-100.

[9] Liacos, J. W., Kam, W., Delfino, R. J., Schauer, J. J., & Sioutas, C. (2012). Characterization of organic, metal and trace element PM2. 5 species and derivation of freeway-based emission rates in Los Angeles, CA. *Science of the total environment, 435*,

[10] Eggen, T., & Lillo, C. (2012). Antidiabetic II drug metformin in plants: uptake and translocation to edible parts of cereals, oily seeds, beans, tomato, squash, carrots, and potatoes. *Journal of agricultural and food chemistry, 60*(28), 6929-6935.

[11] World Health Organization. (1989). Health guidelines for the use of wastewater in agriculture and aquaculture: report of a WHO scientific group [meeting held in Geneva from 18 to 23 November 1987]. World Health Organization.

[12] Wu, X., Conkle, J. L., Ernst, F., & Gan, J. (2014). Treated wastewater irrigation: uptake of pharmaceutical and personal care products by common vegetables under field conditions. *Environmental science & technology, 48*(19), 11286-11293.

[13] Riemenschneider, C., Al-Raggad, M., Moeder, M., Seiwert, B., Salameh, E., & Reemtsma, T. (2016). Pharmaceuticals, their metabolites, and other polar pollutants in field-grown vegetables irrigated with treated municipal wastewater. *Journal of agricultural and food chemistry, 64*(29), 5784-5792.

[14] Christou, A., Karaolia, P., Hapeshi, E., Michael, C., & Fatta-Kassinos, D. (2017). Long-term wastewater irrigation of vegetables in real agricultural systems: concentration of pharmaceuticals in soil, uptake and bioaccumulation in tomato fruits and human health risk assessment. *Water research, 109*, 24-34.

[15] Kalavrouziotis, I. K., Robolas, P., Koukoulakis, P. H., & Papadopoulos, A. H. (2008). Effects of municipal reclaimed wastewater on the macro-and micro-elements status of soil and of Brassica oleracea var. Italica, and B. oleracea var. Gemmifera. *Agricultural water management, 95*(4), 419-426.

[16] Nabulo, G., Oryem-Origa, H., & Diamond, M. (2006). Assessment of lead, cadmium, and zinc contamination of roadside soils, surface films, and vegetables in Kampala City, Uganda. *Environmental Research, 101*(1), 42-52.

[17] Birley, M., & Lock, K. (1999). The health impacts of peri-urban natural resource development.

[18] Santamaria, P. (2006). Nitrate in vegetables: toxicity, content, intake and EC regulation. *Journal of the Science of Food and Agriculture, 86*(1), 10-17.

[19] Castro, E., Manas, M. P., & De Las Heras, J. (2009). Nitrate content of lettuce (Lactuca sativa L.) after fertilization with sewage sludge and irrigation with treated wastewater. *Food Additives and Contaminants, 26*(2), 172-179.

[20] Calderón-Preciado, D., Jiménez-Cartagena, C., Matamoros, V., & Bayona, J. M. (2011). Screening of 47 organic microcontaminants in agricultural irrigation waters and their soil loading. *Water research, 45*(1), 221-231.

[21] Christou, A., Agüera, A., Bayona, J. M., Cytryn, E., Fotopoulos, V., Lambropoulou, D., & Fatta-Kassinos, D. (2017). The potential implications of reclaimed wastewater reuse for irrigation on the agricultural environment: the knowns and unknowns of the fate of antibiotics and antibiotic resistant bacteria and resistance genes–a review. *Water research, 123*, 448-467.

[22] NAHAR, K. M. (2018). DETERMINATION OF PESTICIDE RESIDUES IN CAULIFLOWER AND TOMATO COLLECTED FROM DIFFERENT AREAS OF RANGPUR DISTRICT.

[23] Ahmed, S., Siddique, M. A., Rahman, M., Bari, M. L., & Ferdousi, S. (2019). A study on the prevalence of heavy metals, pesticides, and microbial contaminants and antibiotics resistance pathogens in raw salad vegetables sold in Dhaka, Bangladesh. *Heliyon, 5*(2).

[24] Singh, N. S., Sharma, R., Parween, T., & Patanjali, P. K. (2018). Pesticide contamination and human health risk factor. *Modern age environmental problems and their remediation*, 49-68.