Studies on Pesticide Residues in Soils of Some Selected Spots of Coastal Region of Bangladesh

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Abstract

A study was conducted to determine the presence of insecticide residues including organophosphorous, carbamate and organochlorine in soil samples from vegetables and paddy fields in the coastal district Feni of Bangladesh. Samples collection and preparation were carried out using standard procedures. The concentrations of all the pesticides in the samples were determined using High Performance Liquid Chromatography (HPLC) technique. The result revealed that some samples out of 21 samples were found to be contaminated with organophosphorus (OP) pesticide namely diazinon; carbamate pesticide namely carbofuran and carbaryl ranging from 0.01-0.235 μg/kg and 0.381-3.21 μg/kg respectively. On the other hand, no organochlorine pesticide residue was detected in the soil samples. However, the contamination level of organophosphorous and carbamate was relatively low compared to the IAEA/FAO/Codex Alimentarious Guideline value.

Keywords: Pesticide**,** residue, organophosphorus, carbamate, organochlorine, HPLC

1. Introduction

Bangladesh is a tropical country. Because of the prevailing high temperature and humidity, rapid multiplication of pests occurs in the country and those harmful insects cause intense loss of food production [1, 2]. Every year more than 45% of food production is lost due to pest infestation which leads serious economic loss and hence pests are considered as the major challenge in agriculture. To combat pests, the use of a wide variety of pesticides on agricultural practices in the tropics has increased.

Although the use of pesticides in Bangladesh is relatively low (300g active ingredient/hectare) in comparison to other countries of the world and even much lower than India (380g active ingredient/hectare), consumption of pesticides has now increased and been an inherent part of agriculture in recent years with the introduction of high yielding varieties of crop to control pest and diseases [3-5]. About 33,371 tons formulated products were used in 2016 compared to 18,090 tons in 2003 and 25,479 tons in 2005 [6, 7]. Chemical fertilizers and pesticides have contributed significantly to improve yields of crops, increasing the production of food grains from 9.7 million mt in 1961 to about 20 million mt in 1993 [8]. Because of widespread use of these agrochemicals to increase crop yield and reduce postharvest losses, they are detected in various environmental matrices (soil, water and air) as well as they leave residues in food and thereby produce adverse effects when concentration exceeds the maximum residue limit (MRL). The increased use of these chemicals may show negative effects on the quality of soils and drinking water sources. When entering into the soil, pesticides may be taken up by plants roots and have the potential to cause toxicity to plants, their products and contaminate the food chain. Through leaching and surface runoffs, pesticide residues in soil and the environment may pollute groundwater and surface water, thereby increasing the risk of environmental contamination. Increased accumulation of pesticide residues in the food chain and drinking water have been reported to pose serious human health hazards [9, 10]. Human health hazards vary with the type of the pesticides and also with the extent of exposure. Moderate human health hazards from the misapplication of pesticides include mild headaches, flu, skin rashes, blurred vision and other neurological disorders while rare, but severe human health hazards include paralysis, blindness and even death [11]. International development research centre, Ottawa, has claimed that every year about 10,000 people die and 4,00,000 people suffer from various effects of pesticide poisoning in developing countries [12]. There is a great concern over growing incidence of cancer due to their excessive use [13]. Pesticide residue pollution to the local environment (air, soil and surface water) also affects the lives of birds, wildlife, domestic animals and fish [14]. For the above reasons, use of pesticides has to be controlled to avoid contamination of food supplies and ecological imbalance, but present measures in Bangladesh are inadequate and farmers rarely implement standards [15].

The introduction of organophosphate (OP) and carbamates insecticides were in the 1960s and in 1970s respectively contributed greatly in pest control and agricultural output. Organophosphorous insecticides are the most commonly used and detected pesticides in water streams around the world [16]. In terms of formulated product of carbamates, Bangladesh shared the highest portion (64%) followed by organophosphates [17]. Again, among the pesticides used in agriculture, organochlorine pesticides (OCs) are very toxic and persistent in the environment, which tend to accumulate in living organisms. Although most of them have been banned or restricted after the 1960s in most of the technologically advanced countries, they are still detected in natural ecosystems [18]. Though the organochlorine pesticide DDT was banned in late 1993 in Bangladesh,

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DDT along with its metabolite DDE were found in soil of Narshingdi area [19, 20]. Due to long persistence nature of DDT that may pose a big threat to human, it is a necessity to monitor foods, water, soils and other environmental samples for their presence.

Literature suggests that information regarding the significance of persistence of pesticide residues in soil is very little in Bangladesh and no information is available on levels of pesticide residues in soils of coastal Feni district. So, an attempt was undertaken to assess the types of pesticide residues (i.e. organophosphorous, carbamate and organochlorine) used and their concentration levels in some selected soils extensively used for vegetables and rice cultivation of coastal Feni district of Bangladesh.

2. Materials and Method

2.1 Sampling

Soil samples were collected from Sonagazi upazila, Feni, near the coastal area and were processed for subsequent experiments and necessary analysis. After collecting, the samples were taken to the Agrochemical and Environmental Research Division (AERD), Institute of Food and Radiation Biology (IFRB), Atomic Energy Research Establishment (AERE), Ganakbari, Savar, Dhaka as early as possible and preserved in deep fridge for avoiding loss of the residues.

2.2 Equipments

HPLC: High Performance Liquid Chromatography (Shimadzu, LC-10 ADvp) equipped with a SPD-M 10 Avp, PDA detector; C_{18} Reverse Phase Alltech analytical column (250 × 4.6 mm), Rotary vacuum evaporator (Type -350, USA).

2.3 Extraction

The soil samples were dried at room temperature in a fume cupboard and then made fine powder form by using morter-pastle. To analyze the residues, 50 g of each sample were extracted with 100 ml mixed solution of Hexane and Acetone (1:1) by using electronic shaker. The extract was treated with 5 g anhydrous sodium sulphate to remove traces of water.

2.4 Clean-up

The extract was subjected to clean-up using florisil column chromatography [21]. The top 1.5 cm of the florisil column was packed with anhydrous sodium sulphate. Elution was done with 2% diethyl ether in hexane (5 ml/min). The eluate was concentrated in a rotary vacuum evaporator and transferred to glass-stoppered test tubes. Solvents were completely removed under mild nitrogen flow. The evaporated sample was dissolved in hexane and made to volume in a volumetric flask for subsequent liquid chromatography.

2.5 Analysis

Injections of the aliquots were done by micro syringe into HPLC (High Performance Liquid Chromatography). Quantification was made with a freshly prepared standard curve of the relevant (standard) pesticide. Analysis was done by High Performance Liquid Chromatography fitted with Photo Diode Array Detector [20].

3. Results and Discussion

Twenty-one soil samples collected from vegetables and paddy fields of the Sonagazi upazila of coastal Feni area (Fig 1) of Bangladesh were analyzed for the presence of different pesticide residues and to compare the data with IAEA/FAO/Codex Alimentarious Guideline value. HPLC technique was used as a method of choice for determining the organophosphorus, carbamate and organochlorine pesticide residues analysis in collected sample. A representative chromatogram of the studied samples showing peaks for diazinon (Fig 2a.) and carbaryl (Fig 2b.) has been presented. The analytical results reflected contamination of the soil samples with residues of diazinon, carbofuran and carbaryl pesticides. These results are summarized in Table 1. Table 1 reveals that 3 of 21 soil samples showed the contamination of diazinon compound. The presence of organophosphorus pesticide diazinon was analyzed in SS-11, SS-13 and SS-16 soil samples with a range of 0.01-0.235 µg/kg. The highest concentration (0.235 µg/kg) was found in SS-16 and the lowest concentration (0.01 µg/kg) was in SS-13. Excessive use of Basudin, an organophosphorus pesticide, is the main source of the residue. Table-1 also presents that of the 21 soil samples only 3 samples were contaminated with carbamate residue where 2 samples were

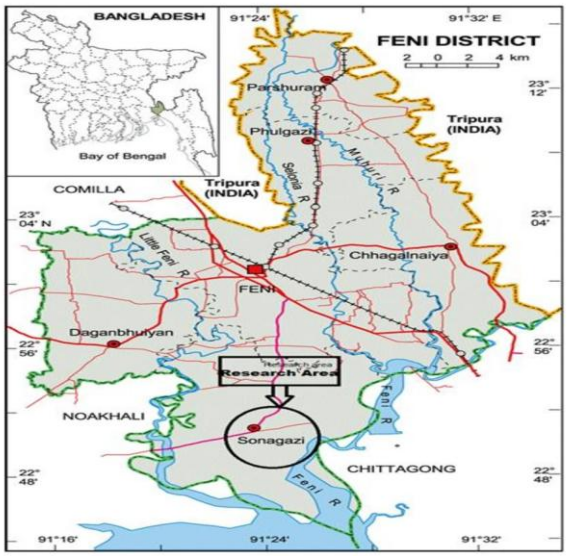

Fig. 1: Location map and sampling points of soil samples

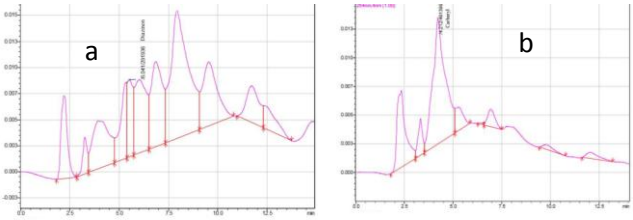

Fig. 2: Representative-chromatogram-of-the-analyzed-samples

Table 1: Amount of Organophosphorus and Carbamate Pesticide Residues in Soil Samples of Sonagazi Upazila in Feni

Sample No.	Pesticide Residues in Soil Samples (μg/kg)		
	Diazinon	Carbofuran	Carbaryl
SS-01	ND	ND	ND
SS-02	ND	ND	ND
SS-03	ND	ND	ND
SS-04	ND	ND	ND
SS-05	ND	ND	ND
SS-06	ND	ND	ND
SS-07	ND	ND	ND
SS-08	ND	ND	ND
SS-09	ND	ND	ND
SS-10	ND	3.21	0.381
SS-11	0.14	ND	ND
SS-12	ND	3.08	ND
SS-13	0.01	ND	ND
SS-14	ND	ND	ND
SS-15	ND	ND	ND
SS-16	0.235	ND	ND
SS-17	ND	ND	2.52
SS-18	ND	ND	ND
SS-19	ND	ND	ND
SS-20	ND	ND	ND
SS-21	ND	ND	ND

Detection limit for HPLC: 10μg/kg, ND: Not Detected

Table 2: Amount of Organochlorine Pesticide Residues in Soil Samples of Sonagazi Upazila in Feni

Sample No.	Pesticide Residues in Soil Samples (μg/kg)		
	DDD	DDE	DDT
SS-01	ND	ND	ND
SS-02	ND	ND	ND
SS-03	ND	ND	ND
SS-04	ND	ND	ND
SS-05	ND	ND	ND
SS-06	ND	ND	ND
SS-07	ND	ND	ND
SS-08	ND	ND	ND
SS-09	ND	ND	ND
SS-10	ND	ND	ND
SS-11	ND	ND	ND
SS-12	ND	ND	ND

Sample No.	Pesticide Residues in Soil Samples (μg/kg)		
	DDD	DDE	DDT
SS-13	ND	ND	ND
SS-14	ND	ND	ND
SS-15	ND	ND	ND
SS-16	ND	ND	ND
SS-17	ND	ND	ND
SS-18	ND	ND	ND
SS-19	ND	ND	ND
SS-20	ND	ND	ND
SS-21	ND	ND	ND

Detection limit for HPLC: 10μg/kg, ND: Not detected

found to be contaminated with carbaryl compound and 2 with carbofuran compound. Carbaryl residue was observed in SS-10 and SS-17 samples where the highest concentration (2.52 μg/kg) was found in SS-17 and the lowest concentration (0.381 μg/kg) was in SS-10. The carbofuran pesticide was detected in SS-10 and SS-12. The highest concentration of 3.21μg/kg was analyzed in SS-10 and the lowest concentration (3.08 μg/kg) was in SS-12. Different factors such as persistence of pesticides, availability in use, indiscriminate use and lack of consciousness are considered for the presence of these residues. However, the contamination level of organophosphorous and carbamate was relatively low compared to the IAEA/FAO/Codex Alimentarious Guideline value. The wide use of pesticides in the world causes major health and environmental problems. It is necessary to learn more about the problems caused by exposure to pesticides with respect to safety, health and the environment. It has been reported in the press and quoted from the farmers of grass roots level that pest from fields treated with pesticides move to the adjacent fields forcing the owners of these fields also to use chemicals as well. It was also mentioned quoting farmers that the pesticide company dealers try to motivate farmers of a village to use pesticide on their crops and naturally the other farmers also follow to avoid attack by pests [22]. The farmers and the inhabitants of the study areas should be educated on the dangers of pesticides for pest control. It should be noted that countries like Bangladesh did not have necessary resources and infrastructures to adequately regulate the use of pesticides. Proper regulatory enforcement of the relevant rules and provisions, and regular monitoring of residues would prevent misuses and could minimize the environmental problems.

Table-2 explores that the studied soil samples were free from organochlorine residues DDT, DDD and DDE. The absence of DDT along with its metabolite DDD and DDE indicated the growing awareness of its ill effects amongst the farmers.

The findings of this study suggest that the soil quality of Sonagazi upazila is better than those from other parts of Bangladesh in terms of pesticide residues [20]. This study can only provide some baseline data which deserve further investigation so that a concluding remark can be made regarding the present status of residual level in different environmental soil samples of the area.

4. Conclusion

The presence of various agrochemicals such as diazinon, carbofuran and carbaryl pesticides in the samples analyzed was an indication of the use of the pesticides by farmers in the study area to control pest and diseases. Though the soil was contaminated with organophosphate and carbamate pesticide residues, they were within the range of IAEA/FAO/Codex Alimentarious Guideline value. Despite the low level of contamination in the studied soils, the best environmental management in the vegetable and rice production area requires the regular monitoring of soil contamination level in the coastal Feni district.

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