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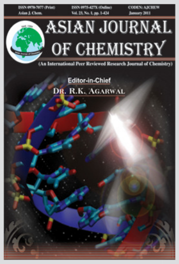

Analysis of the Carbofuran Pesticide Residue in the Water from Banana Plantation in Wayanad District, Kerala, India

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This research focused on the pesticide residue analysis of water samples collected from five different parts of Wayanad district of Kerala state, India. The main plantation of the inhabitants here is banana, which always requires a protection from pesticides for satisfactory yield. This is due to its low pest resistance. The unscientific and increased use of harmful pesticides in the banana planted land has resulted in enhanced soil and water pollution. Extraction and quantification of pesticide residues from the water sample was carried out by using optimized cleaning procedures and concentration methods using HPLC. The recovery of carbofuran from the water varied from 0.186-0.262 ppm. Most of the samples contained carbofuran in varying concentrations. The amount of carbofuran retained from the water sample from five different places in Wayanad district varied in the order Thavinjal < PeriyaII < Periya I < Alattil < Vengoor < Varayal. This result could be very well correlated with the pH of the soil from which the water was collected. Other factors such as manuring of the soil, moisture content, climatic conditions and temperature (below 35 ºC) *etc*., were also examined for possible correlations, but none of them was found to be directly influencing the presence and persistence of carbofuran in the water.

Key Words: HPLC, Carbofuran, Pesticide residue, Banana plantation, Wayanad District.

INTRODUCTION

Wayanad district in Kerala is noted for the fertility of its soil, agricultural diversity and the pleasant climate without any extremes[1]. Various factors such as increased cost of living, non-availability of enough land for agriculture, *etc*. paved the way for the mass migration of people from other parts of the state to Wayanad[1]. The new migrants exploited the fertility of the land to meet the growing demand from the surrounding regions of around 100 km area, for various agricultural products such as banana. This increased demand created a pressure on the farmers for enhanced production rate of banana to feed the majority of the population in the state but this demand was met with the uncontrolled use of pesticides, such as carbofuran and endosulfan[2]. This resulted in the increased production rate but was accompanied by the development of more virulent pests within-built resistance to some of the frequently used chemicals and the increased number of patients having incurable diseases[3].

The present research focussed on the carbofuran analysis of water samples collected from various parts of Wayanad district, Kerala using high performance liquid chromatography (HPLC).

EXPERIMENTAL

Carbofuran technical grade: Technical grade carbofuran manufactured by Pestanal, Sigma-Aldrich, Germany supplied by M/s. F.M.C. Corporation, Middleport, New York was used for the preparation of standard solutions.

Carbofuran commercial grade: Furadan 3G, used by the farmers is granular formulation of carbofuran (Rallis India Ltd., Mumbai) containing 3 % of active ingredient was used for the study.

Collection of water samples: Water samples from five different banana growing locations of Wayanad District namely Periya, Allattil, Vengur, Thavinjal and Varayal were collectedin pre-washed 2 L cans. In these regions, the use of pesticide was found to be extensive for the control of banana asphids. Water samples were collected from different agricultural field drains water samples were collected. Before collection the cans were rinsed twice with sample. Since, many of N-methyl carbamates are prone to hydrolysis at the pH of natural water, the addition of acid (pH = 2) is recommended. Photochemical changes are possible and so the samples were stored in the dark[4].

Stock solution: Exactly 1.62 mg of carbofuran was weighed and dissolved in acetonitrile and then made up to in a 100 mL standard volumetric flask to get 16.2 ppm solution, which was used as the stock solution.

Preparation of carbofuran standard: 1.2, 3.7, 6.2 mL of the stock solution of carbofuran in acetonitrile was taken in three different 10 mL standard flasks and made up to mark using acetonitrile to give 2, 6, 10 ppm of carbofuran, respectively.

Fortification: 2 mL of the stock solution of carbofuran in acetonitrile was taken in two different 100 mL stoppered conical flasks to give 0.0324 mg of carbofuran. The organic layer of acetonitrile was evaporated by keeping over a water bath. The flasks were cooled and 50 mL of distilled water was added to it. Then the flasks were shaken for 1 hour. Two blanks were also prepared using acetonitrile alone without any pesticides to run as control.

Extraction of fortified water sample: Each of the fortified water samples was transferred quantitatively into 125 mL separating funnels. 5 mL of dichloromethane was added to the separating funnel and equilibrated. The extraction was repeated for two times using the same quantity of dichloromethane and organic layer was collected into 100 mL stoppered conical flask. The organic layer with the extracted carbofuran residue was passed through a column filled with Na_2SO_4 supported over a glass wool for cleaning to remove any moisture in it. The organic layer was concentrated under vacuum to about 2 mL and this process was repeated using 5 mL acetonitrile and then diluted to 10 mL with acetonitrile. The blank was also run following the same procedure.

Extraction and concentration of carbofuran from water samples 500 mL of water sample was taken in a beaker and added about 10 g of anhydrous sodium sulphate and dissolved. This water sample was taken in a 500 mL separating funnel, added 40 mL dichloromethane to it and equilibrated. The organic layer was separated and collected in a flask. This step was repeated two times by 20 mL dichloromethane in each.

RESULTS AND DISCUSSION

The retention time obtained for carbofuran under the HPLC conditions using acetonitrile:water (40:60) eluent was 8.2 min. The peak areas obtained for the standards in duplicate are presented in the Table-1 and the calibration curve are shown in the Fig. 1.

TABLE-1
HPLC RESULTS OF THE ANALYSIS OF CARBOFURAN STANDARDS

Concentration of standard carbofuran (mg/L)	Peak area		
	1	2	Mean
2	26650	26106	26378
6	85824	81100	83462
10	133617	133588	133602

After fortification of standards in water, the residues were extracted and measured using HPLC. The results obtained are given in Table-2. Percentage recovery obtained for two experiments was 75.9 and 76.8 with an average recovery of 76.3%. This values is considered for the present study.

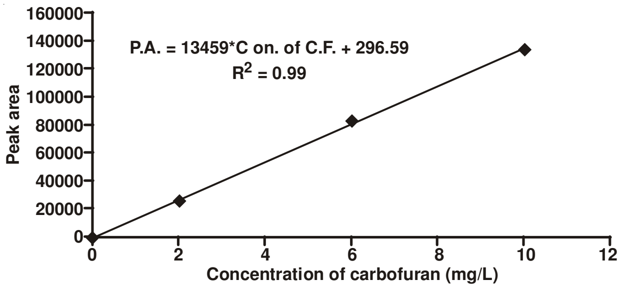

Fig. 1. Calibration curve

Level of carbofuran in water samples: Drain water from field channels samples were collected and extracted using suitable solvents and presence of carbofuran was analyzed quantitatively using HPLC. Using the standard curve, the concentration of carbofuran present in water samples were determined and presented in Table-2. A correlation between the pH of the soil and recovered concentration of the carbofuran can be successfully made (Table-3). The higher acidity of the soil discourages the adsorption and absorption of the carbofuran in the soil, which leads to the higher desorption of the pesticide. This fact is responsible for the higher concentration of carbofuran recovered with reduction in acidity.

TABLE-2
RESULTS OF RECOVERY FROM FORTIFIED SAMPLES EXPERIMENTS USING HPLC

Sample	Fortified concentration (ppm)	Observed concentration (ppm)	Recovery (%)
RW-1	3.24	2.46	75.9
RW-2	3.24	2.49	76.8

TABLE-3
EXTRACTION OF CARBOFURAN FROM WATER SAMPLES

Sample area	pH	Peak area	Conc. as per graph	Amount present in 1 L water sample	Actual conc. incorporating recovery
Varayal	4.3	145351.5	9.960	0.200	0.262
Vengoor	4.8	256182.0	17.596	0.176	0.231
Alattil	5.1	221775.5	15.225	0.152	0.200
Periya 1	5.1	211312.5	14.504	0.145	0.190
Periya II	5.3	206325.5	14.161	0.142	0.186
Thavinjal	5.3	125899.0	8.620	0.086	0.113

Recovery of carbofuran from fortified water samples: The retention time (R_t) of carbofuran was found to be 8.9 min in all cases. Percentage recovery obtained for two experiments was 75.9 and 76.8 with an average recovery of 76.3 %. The observed lower percentage recovery is due to the hydrolysis of the pesticide at the pH of natural water. Photochemical changes are also responsible for the above observation.

Recovery of carbofuran from plantation water samples: It is observed that in drain water samples the carbofuran concentration ranges from 0.186 to 0.262 ppm per litre of water sample. Since, the higher acidity of the soil discourage the adsorption and absorption of the carbofuran in the soil so, it may be easily washed off in the drained water. This leads to a a higher value of pesticide in the chromatograms of the drained water samples. This can be made more clear with a comparison of the pH values of the soil in the selected regions (Table-3). Varayal with the lowest pH value (and hence highest acidity) tend to release the pesticide without considerable adsorption and absorption and hence the highest recovery of pesticide was obtained (0.262 ppm). Similarly, Thavinjal with the highest pH value and hence lowest acidity tend to retain the pesticide by the effective adsorption and absorption processes, which seldom release the pesticide in the drained water. Other samples also follow the same trend.

Conclusions

Percentage recovery obtained for two recovery experiments from fortified water samples were 75.9 and 76.8 with an average recovery of 76.3 %. This lower value can be attributed to the hydrolysis of the pesticide at the pH of natural water. Drained water samples contained carbofuran concentrations in the range from 0.186 to 0.262 ppm per litre of water sample. This study focussed the influence of the soil pH on the absorption and adsorption of the furudan and hence its washing off from the soil by water indicated a direct relation between pH and tendency to absorption/ adsorption by the soil.

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