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Spectrophotometric Interaction of Carbofuran on Food Grains

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Abstract

Carbofuran is a broad-spectrum insecticide and is used for foliar treatment of cotton, fruits, vegetables, and commercial ornamentals field crops and also in dairies and poultry cultures. Though it facilitates in farming and medicinal point of view, it has hazardous effects by it's over uses. Currently we have focused our study on its interaction with food grains (maize, black pulse, pea, gram, wheat and soybean) by the UV- spectrophotometric technique. Here we have studied the recovery, formulation, and residual analysis by using UV- spectrophotometric technique. It has observed that carbofuran absorbed by food grains, as recovery range lies between 84% to 98% with regression coefficient 0.93 to 0.97 and higher residual ranges were obtained at higher concentration and least at low concentration (3 to 27%) with regression coefficient 0.95 to 0.98.

Keywords: Carbofuran, siderophore, FTIR and UV- Spectrophotometric analysis.

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Introduction

Carbamate pesticides are being used rapidly in crop protection from various pests, weeds from the last four decades, due to broad spectrum usage, high effectiveness and low environmental health hazards. However, their use in cottons, cereal crops, vegetables, and fruits protection poses serious risk to humans, plants and animals [1]. Carbofuran (Methyl-carbamic acid 2,2-dimethyl-2,3-dihydro-benzofuran-7-yl ester) was introduced as a broad-spectrum insecticide [2]. It has been evolved from carbamates.[2.] It slowly decomposes in water and the rate is influenced with increase in aeration, salinity, alkalinity and temperature. Carbofuran is highly effective in two different ways: (a) as a "contact insecticide," as it hinders pests' growth when come in direct contact and second (b) as a "systemic insecticide" it effects various organs by affecting different metabolic pathways. It also has direct effect on photosystem I and II of plant systems. Its molecular formula is $C_{12}H_{15}NO_3$ and its structure is given in figure 1[3,4].

Carbofuran has well-known mode of action via inhibition of the AChE at nerve junction. Carbofuran is acute toxic as characterized by signs of poisoning typical of anticholinesterase action [5-9]. Carbofuran is a potent inhibitor of cholinesterase an enzyme of acetylcholinesterase. The carbofuran poisoning include abdominal cramps, nausea, muscle tremors, blurred vision, weakness, headache, constriction of pupils, chest discomfort, sweating, and decreased pulse [10-16].

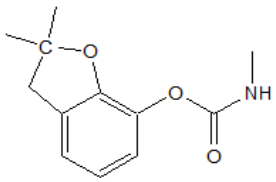

Figure 1: Structure of Carbofuran

Various analytical studies viz. HPLC, UV, GC, HPLC-UV, NMR, Mass- spectroscopy, etc. studied on carbofuran to check the activity, toxicity, degradation, environmental fate etc. [15-26] In current study we have developed the UV-Spectroscopic method for the determination of carbofuran in food grains namely maize, black pulse, pea, gram, wheat and soybean. Also we have checked the formulation grade quality by UV-Spectroscopic method.

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2. Experimentation

2.1 Purification of Carbofuran

Commercial formulation of carbofuran (3%) with trade name Furadan Ultra, obtained from FMC Pvt. Ltd. Was purified by using different laboratory techniques *viz.* solid-liquid extraction with acetone, then with column chromatography on alumina eluted with benzene-chloroform mixture (1:1) followed by crystallization in chloroform-petroleum ether mixture. White needle type crystals were obtained.

2.2 Calibration plot

A solution of 1000 ppm was prepared by dissolving 100 mg of pure form of `carbofuran into 100 mL acetonitrile. A 100 ppm stoke solution was prepared by taking 10 mL of 1000 ppm into 100 mL volumetric flask and 90 mL of acetonitrile was added. Now from 100 ppm solution different concentrations ranged between 10 ppm to 100 ppm were prepared. By setting the λ_{max} 280 nm the absorbance (Abs.) of different concentrations (10 to 100 ppm) were observed by UV-Spectrophotometer. Then a graph was prepared between Abs. (along y-axis).

2.3 Pre-treatment of food grains

Food grains viz. Maize, Gram, Pea, Wheat and Black pulse were washed well by using excess of water and then dry in oven at 60 degree centigrade for 24 h for further experimental purpose.

2.5 Recovery Analysis

A 100 ppm stoke solution was prepared by taking 10 mL of 1000 ppm into 100 mL volumetric flask and 90 mL of acetonitrile was added. Now from 100 ppm solution different concentrations ranged between 10 ppm to 100 ppm were prepared.50 samples were prepared i.e. 5 each for above concentrations for 5 different food grains viz. Maize, Gram, Pea, Wheat, Soybean and Black pulse in the culture tubes. These tubes were shaken well for 5 minutes. After 24 h the solutions of these tubes were filtered by using whatmann no.1 filter paper and absorbance were noted for these 50 samples by UV-vis spectrophotometer.

2.6 Formulation Analysis

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.0 g was extracted five times with 25 ml of acetone from commercial formulation Furadon® (carbofuran, 3%) and combined volume were dried under vacuum. The dry mass of the carbofuran was then dissolved in acetonitrile (25 mL) & then filtered by using Whatmann no.1 filter paper. Filtered solutions were evaporated & dissolved in pure acetonitrile (8.0 mg/ 10mL) and a concentration of 90 ppm was prepared. Chromatogram was compared with that of standard samples.

2.7 Residual Analysis

3.33 gm of commercial formulation of carbofuran was dissolved in 100 mL acetonitrile and then different concentrations ranged from 100 to 50 ppm were prepared. Each concentration sprayed on 50 gm food grains and these food grains dried at room temperature. Then these food grains were put into culture tubes having 10 mL acetonitrile in each.These tubes shaken well for 5 minutes. After 24 h the solutions of these tubes were filtered by using Whatmann no. 1 filter paper and absorbance were noted for these each samples by UV-vis spectrophotometer. Then chromatograms of each concentration were compared with their original chromatograms.

3. Results and Discussion

3.1 Method Development

Ultraviolet (UV) spectroscopy of organic compounds usually indicates little about structural characteristics, organic compounds that contain certain functional such as carbonyls, carboxylates, aldehydes, ketones, and esters have UV absorption maxima in the range of 200 to 400 nm. Carbofuran molecule having the ketones as well alkenic (benzene) group, it would absorb near the 275nm. By setting the maximum wavelength with higher absorbance it is easy to analyze the absorption of carbofuran with different analytes or food grains.

The goal sought in separating and detecting carbofuran in a single run by UV method were to achieve good peak resolution in short time, reproducibility & having low detection limit durability. For the method development therefore, we first determined the optimal wavelength at selected wavelength that is ʎmax. 280nm, as sensitivity plays an important procedure for determining environmental pesticides residues in environmental matrices, i.e. ability of the discriminate components between the compounds of interest & any colluded material is also equally important. For UV absorbance detection, short wavelength always results in low selectivity. That is, more interference occurred in the analysis of real samples

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for determining the pesticide residues. Thus, as a compromise the 280 nm wavelength was selected, although this led to considerably lower detection limit for carbofuran.

3.4 Formulation Analysis

In formulation analysis the chromatograms of pure carbofuran and commercial formulation were compared at 90 ppm, it observed that the formulated carbofuran have 2.85 % composition instead of 3.00 %.

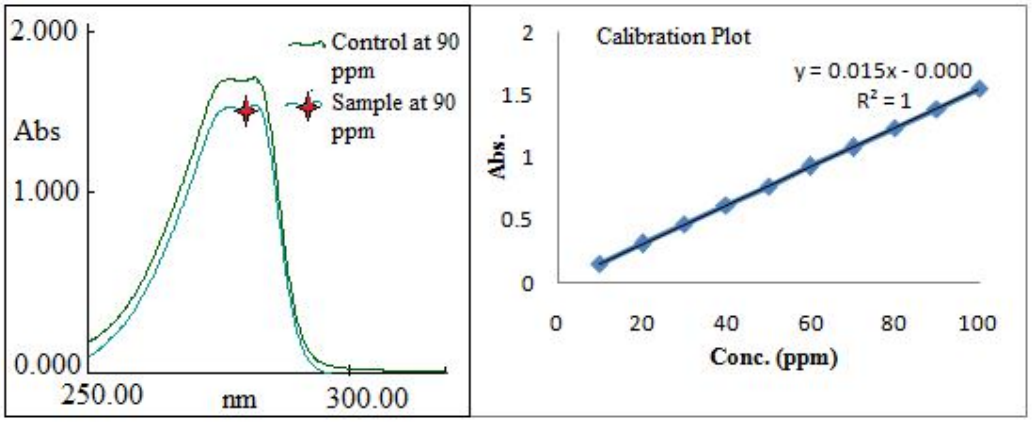

Figure 2: UV overlay curves for carbofuran at 90 ppm of pure and 90 ppm of commercial formulation (from top to bottom) at λ_{max} 280 nm

3.3 Recovery analysis

At different concentrations from 10 to 100ppm, it was observed that the different results were obtained with almost high regression coefficient R^2=0.997. As the concentration was raised from 10 ppm to 100 ppm the value of recovered carbofuran decrease and more recovery was observed in black pulse and least in pea, this happened due to the surface area of the food grain i.e. greater the surface area greater the absorbance as shown in figure. The overall result indicates that at low concentrations recovery is more, range of recovery were found between 84 to 98%. Regression analysis of the food grains at different concentrations with their UV absorptions indicated a high degree of linearity at 280 nm. The R^2 exceeded 0.95 in all regression lines at 280 nm. The high degree of linearity signifies that these wavelengths may be used for analytical determinations of carbofuran in food grains and other eatables, in water samples, soil commodities etc.

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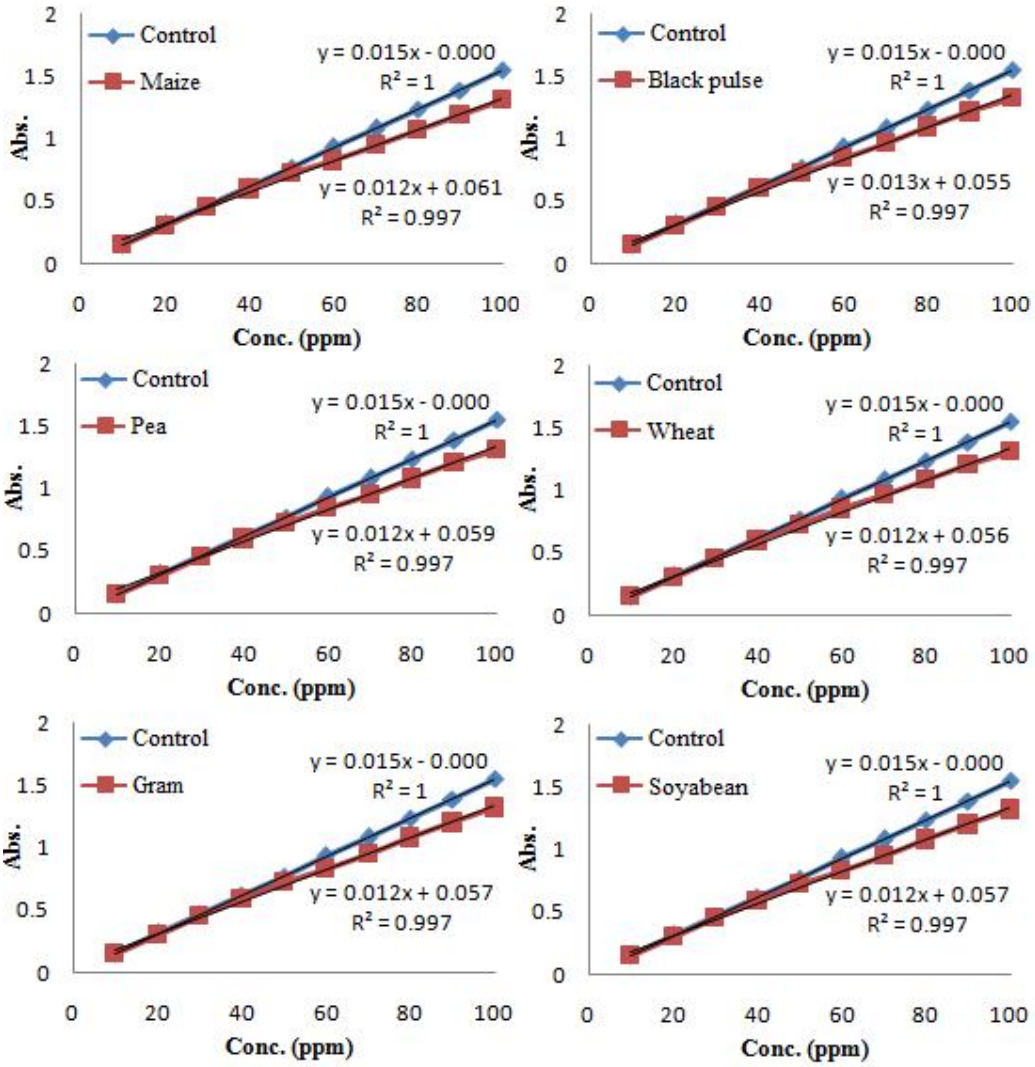

Figure 3: Recovery plot for carbofuran at 10 ppm to 100 ppm of pea, maize, gram, wheat and black pulse samples

3.5 Residual Analysis:

Residual analysis done by sprayed the different concentrations of formulated carbofuran, each food grain have the 50 gm weight. The maximum residue observed at higher concentration, and in the pea because of larger surface area, least in black pulse due to of small surface area.

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Table 1. Residual analysis (%) for carbofuran at 50 ppm to 100 ppm of pea, maize, gram, wheat, black pulse and soybean samples

Conc. In ppm	Reside found in ppm per 50 gm ± 4% S.D					
	Maize	**Black pulse**	**Pea**	**Wheat**	**Gram**	**Soybean**
50	13.28	11.53	13.85	12.11	9.28	11.24
60	20.11	18.96	19.10	19.03	19.96	18.76
70	39.71	29.21	30.92	29.28	35.82	31.32
80	42.35	37.39	41.03	38.39	42.03	39.36
90	46.85	41.07	44.28	41.35	44.53	43.65
100	49.35	44.21	46.78	46.01	48.07	46.02

4. Conclusion

After the analytical treatment to carbofuran at various food grains viz. Maize, black pulse, pea, gram and wheat it is conclude that in case of recovery analysis the range of recovery is lies between 84% to 98%, hence from recovery analysis it observed that at low concentration maximum recovery was observed. In case of formulation analysis, commercial formulated carbofuran have the 2.85% composition instead of 3%. While in case of residual analysis most residues were obtained at higher concentration and least at low concentration, also whole study depends upon the surface area of the food grain i.e. greater the surface area greater the absorbance. We are therefore able to conclude that the application of minimal dose of carbofuran on to the food grains is beneficial in order to minimize residual and persistence of carbofuran in the food grains. The linear relationship between concentration and UV absorbance of carbofuran provides a useful analytical method for the determination of carbofuran in food grains.

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