Punjab Univ. J. Zool., Vol. 12, pp. 31-34, 1997

USE OF ULTRA-VIOLET SPECTROPHOTOMETRY FOR DETERMINATION OF INSECTICIDES AND AROMATIC HYDROCARBON POLLUTANTS

SYED SHAHID ALI, RIAZ UL HAQ, MUBASSHIRAH KHALIQ AND A.R. SHAKOORI

Department of Zoology, University of the Punjab, Quaid-e-Azam Campus, Lahore-54590, Pakistan

Abstract: Insecticides and other aromatic hydrocarbons are major pollutants in our environment. Their biodegradation studies involve determination of the quantity of these compounds, their residues or intermediates left over during the process. Their determinations involve high cost instruments and tedious preparations. In the present report UV absorption picture of some aromatic hydrocarbons (phenol and sodium benzoate) and insecticides (diazinon, chlorfenvinphos, fenitrothion, chlorpyriphos, methyl parathion, monocrotophos, profenophos, methomidophos and dichlorvos) was taken which showed a definite pattern of absorption ranges and the wavelength scans indicated a specific wavelength at which the absorption was maximum. These UV absorption spectra were indicated to be useful and economical for evaluation of the pesticides and determination of their biodegradation.

Key words: UV absorption spectra, organophosphates, pesticides, insecticides, aromatic hydrocarbons, wavelength scan.

INTRODUCTION

Macromolecules like DNA and proteins absorb ultraviolet (UV) radiation at 260 and 280 nm wavelengths respectively, due to the presence of aromatic rings in nucleotides of DNA and aromatic amino acids *i.e.* phenylalanine, tyrosine and tryptophan in proteins. UV absorption phenomenon has been used to estimate the genome size of various organisms, to determine the repeated DNA sequences and the amount of DNA and proteins in solutions (Britten and Kohne, 1971; Jelenek and Schmid, 1982; Cedergren, 1993). Some of the common techniques employed for the determination of organic chemicals are high performance liquid chromatography (HPLC), gas chromatography, UV spectrophotometry and particle beam mass spectrometry. UV spectrophotometry has been widely used for the determination of various types of chemicals and their derivatives (Hooijerink *et al.*, 1991; Kim *et al.*, 1991). The technique in some form has been used for the determination of aromatic sulfonic acid from aquatic environment (Cocheci and Gitye, 1989; Kim *et al.*, 1991). In other cases determination of several industrial chemicals, insecticides, herbicides, phenoxy acids from soil, drinking water and other aquatic environments is reported (Braithwaite and Smith, 1990; Marvin *et al.*, 1991; Kim *et al.*, 1991).

0079-8045/97/0001-0029 $ 03.00/0

UV absorption patterns correlate with the structure of the organic molecules. Although aliphatic hydrocarbons also show UV absorption pictures particularly if they have resonance in the molecular structure due to alternate double and single bonds, however aromatic hydrocarbons or partially aromatized molecules give a characteristic UV absorption picture. These spectra can be used as indicators of qualitative and quantitative evaluation of the benzenoid compounds (Kurzer and Chapman, 1989). A large number of insecticides contain benzene or substituted benzene rings as a part of their molecular structure. These pesticides have usually two fates, either these get entry into food chains and thus reach non target animals causing health hazard or they are biodegraded by microorganisms present in soil or water. It is difficult to estimate the amount present in the environment due to high cost instruments involved. UV spectra of the insecticides were obtained to correlate the amount and type of the insecticide present in the media used for the growth of presumptive insecticide degrading bacteria. The study, use and improvement of insecticide degrading bacteria would aid in removing insecticides from the environment.

MATERIALS AND METHODS

UV absorption spectra of phenol and benzoate

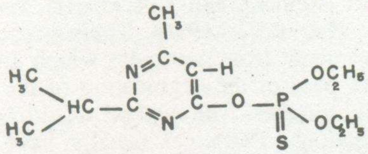
Phenol was taken as an initial material to take UV absorption spectra. A U2000-Hitachi spectrophotometer was used to scan the various wavelengths for determination of maximum UV absorption of phenol. Phenol was dissolved in water to prepare 10 ppm solution. Distilled water was used as a blank for reference. Different concentrations of phenol were used for UV absorption spectra to check the level or wavelength range of maximum absorption. Another referenced aromatic chemical used was sodium benzoate. All the readings were repeated at least three time to take the means.

UV absorption of insecticides

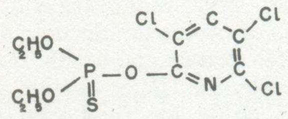
Commercial samples of locally used organophosphate insecticides namely, diazinon, chlorpyrifos, chlorfenvinphos, fenitrothion, methylparathion, profenofos, methamidophos, dichlorvos and monocrotophos, were used to make various dilutions. Wavelength scan for UV absorption at different λ values was done by taking different values of wavelength on x-axis and their respective absorbance on y-axis. The plot showed the wavelength at which the maximum absorbance was obtained.

RESULTS AND DISCUSSION

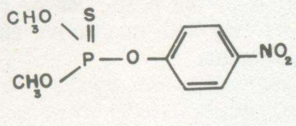
The wavelength scan showed maximum absorption of phenol at wavelength ranging from 230-235nm. However, the plateau of the curve ranged from 280 to 195nm with a depression ranging from 235 to 245nm. The characteristic pattern was got repeatedly to exclude experimental error. The peak of the maximum absorption curve increased with the increase in concentration of phenol in the solution. Sodium benzoate solution in water showed maximum absorbance at 235nm, however, the plateau of the curve ranged



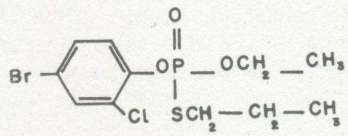
Diazinon



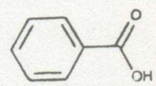
Chlorpyrifos



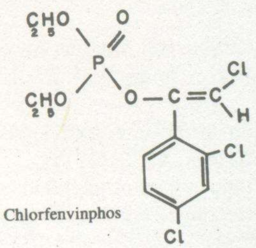
Methyl parathion



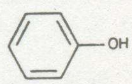
Profenofos



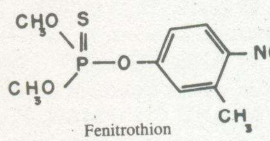
Benzoate



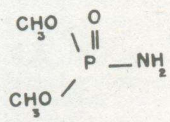
Chlorfenvinphos



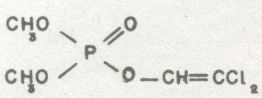
Phenol



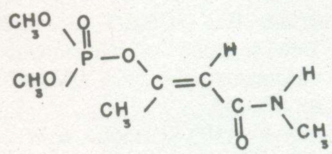
Fenitrothion



Methamidophos



Dichlorvos



Monocrotophos

from 285 to 195nm. There was no depression on the plateau. Diazinon, chlorfenvinphos and fenitrothion showed maximum absorption in a wavelength range of 290-300nm; chlorpyrifos in a range 300-310nm; methylparathion, monocrotophos and profenofos at 300nm; methamidophos and dichlorvos at 290nm.

Aromatic hydrocarbons pollutants get entry into the ecosystems as products of plant metabolism, wastes from industry and agricultural practices. Another big source of pollution and contamination is the pesticide industry. A huge quantity of insecticides is used every year to control pests of agricultural importance but unfortunately these pesticides are not being degraded at the rate to cope with the inflax. Thus many of the pesticides, particularly the insecticides are being accumulated in the ecosystems, food chains and living tissues. Recently attention has been diverted to the microorganisms important in biodegradation of pesticides (Reincke and Knackmuss, 1988; Eaton and Chapman, 1992; Mahmood *et al.*, 1994; Haq *et al.*, 1996). These microorganisms are the tools of choice for cleaning the environment from pesticides which are becoming an ecological menace and health hazard. The pace of the degradation of the pesticides can be traced by the UV absorption spectrophotometry. The method would be easy, speedy and less costly for these kind of estimations. Pesticides usually have one or more aromatic rings as a part of their molecular structure. These are the basis of UV absorption. Biodegradation, in most of the cases, involve the breakage of benzene rings with the consequent change in the UV absorption of the pesticides or its degradative intermediates. UV absorption patterns would correlate with qualitative and quantitative evaluation of the pesticides and other aromatic pollutants.

REFERENCES

BRITTEN, R.J. AND KOHNE, D.E., 1970. Repeated segments of DNA. *Scientific American,* **222**: 24-31.

CEDERGREN, R., 1993. Nucleic acids. In: *Essentials of Molecular Biology*. Second edition, pp. 42-49 (eds. D. Freifelder and G.M. Malacinski), Jones and Bartlette Publishers, Bostonm, London.

COCHECI, V. AND GITYE, V., 1989. Phenol reduction in the biological treatment step of a waste waters treatment town station. *Revista DeChimie*, **40**: 916-919.

EATON, R.W. AND CHAPMAN, P.J., 1992. Bacterial metabolism of naphthalene: construction and use of recombinant bacteria to study ring cleavage of 1,2-dihydroxynaphthalene and subsequent reactions. *J. Bacteriol.,* **174**: 7542-7554.

HAQ, R., MAHMOOD, A. AND SHAKOORI, A.R., 1996. Isolation and characterization of plasmids from hydrocarbon degrading bacteria of soil samples. *Pakistan J. Zool.,* **28**: 63-68.

HOOIJERINK, H., SCHILT, R., HAASNOOT, W. AND COURTHEIJN, D., 1991. Determination of clenbuterol in urine of calves by high performance liquid chromatography, with UV and electrochemical detection. *J. Pharm. Biomed. Analysis* **9**: 485-492.

JELENIK, W.R. AND SCHMID, C.W., 1982. Repititive sequences in eukaryotic DNA and their expression. *Annu. Rev. Biochem.* **51**: 813-844.

KIM, G.H., LEE, J.H. AND CHO, K.Y., 1991. Inheritance of fenvalerate resistance in the diamond back moth, *Plutella xylostella* Linn. *Korean J. Appl. Entomol.*, **30**: 106-110.

KURZER, F. AND CHAPMAN, D., 1989. Correlation of structure and UV absorption characteristics in tricyclotridecane. *Spectroscopy*, **7**: 261-282.

MAHMOOD, A., HAQ, R. AND SHAKOORI, A.R., 1994. Isolation of bacteria of *Pseudomonas* and *Enterobacter* spp. from soil and study of their ability to degrade organic pollutants. *Punjab Univ. J. Zool.,* **9**: 89-92.

MARVIN, C.H., BRINDLE, I.D., HALL, C.D. AND CHIBA, M., 1991. Rapid on line precolumn high performance liquid chromatographic method for the determination of benomyl, carbendazim and aldicarb species in drinking water. *J. Chromat.*, **555**: 147-154.

REINCKE, W. AND KNACKMUSS, H.J., 1988. Microbial degradation of haloaromatics. *Ann. Rev. Microbiol.*, **42**: 263-287.

(*Received: October 10, 1996*)