SYNTHESIS AND INSECTICIDAL EVALUATION OF O-(PHENYL) / O-(4-NITRO-PHENYL) O-(ALKYL BENZIMIDAZOLYL-2) PHOSPHOROTHIOATES

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ABSTRACT: O-(phenyl)/O-(4-nitrophenyl)O-(alkyl benzimidazolyl-2) phosphorothioate derivatives were synthesized and characterized on the basis of elemental analyses, M.P. IR, ^{1}H NMR and mass spectral studies. Their, insecticidal activity was evaluated against *Periplanata americana* (Indian cockroach) by using contact and topical methods and were found to be quite active in this respect.

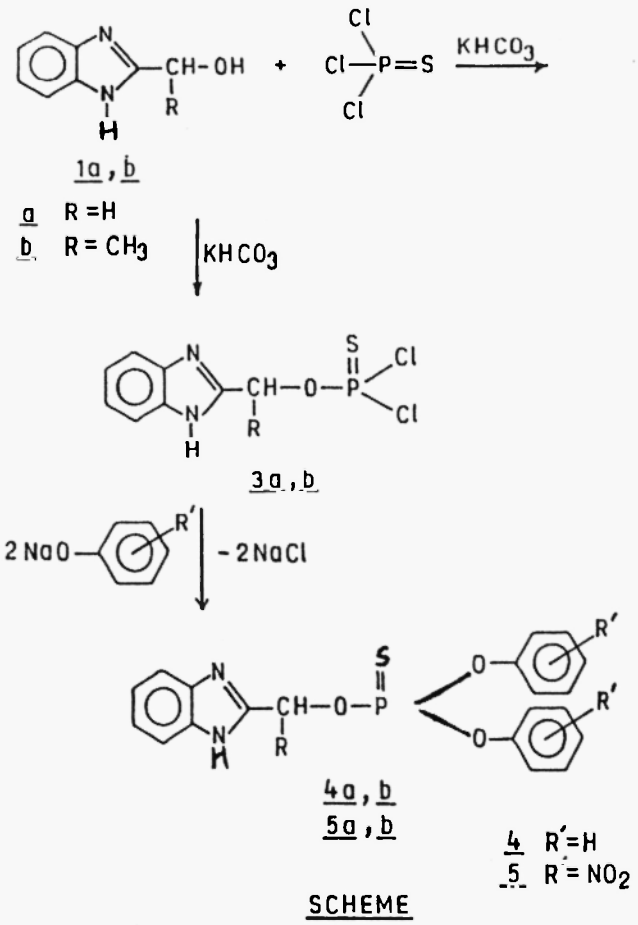
INTRODUCTION

Organophosphorus compounds possess significant insecticidal, acaricidal and fungicidal properties (1) due of their enzyme inhibitory activity towards acetyl cholinesterase (AchE) (2). Literature survey (3) indicated that organophosphorus compounds containing N-heterocyclic substituents such as imidazole, increases the protonation at the site of action of pesticides and other biocides and facilitates the phosphorylation of acetylcholinesterase enzyme.

Recently Takasuka and Coworkers (8) have reported the insecticidal, miticidal and nematocidal organophosphorus compounds containing 2-(nitro imino imidazolidine). Similarly organophosphorus soil pesticides containing 5-6 membered heterocyclic substituents have also been patented (9). Earlier Vyas *et al.* (10) have also reported the synthesis and insecticidal activity of O-(alkyl benzimidazolyl-2) phosphorates and phosphorothioates. In view of the above observations and in continuation to our work, we wish to report herein the synthesis of O-(phenyl)/O(4-nitro phenyl)O(alkyl benzimidazolyl-2) phosphorothioate derivatives (4a,b - 6a,b). These were characterised on the basis of elemental analysis, M.P, IR, ^{1}H NMR and mass spectral studies. The insecticidal activity of these derivatives was evaluated against *Periplanata americana* (Indian cockroach) by using contact and topical methods (11).

EXPERIMENTAL

All the chemicals were of BDH and E. Merck grade and used after purification. The solvents were dried by the standard procedures 2-(hydroxymethyl) benzimidazole 1a (M.P.-171°C) and 2 (1-hydroxyethyl) benzimidazole 1b (M.P.-175°C) were prepared by condensing o-phenylene diamine with glycollic and lactic acid respectively according to the procedure described by Phillips *et al.* (12). Purity of the samples were ascertained by running TLC in tetrahydrofuran, pet-ether and DMF-acetone mixture on silica gel-G plates and spots were visualised by iodine vapours. Melting points were determined in a sealed evaluated capillary tubes and are uncorrected. The IR spectra were recorded in KBr on a Perkin-Elmer 577 grating IR spectrophotometer. The ^1H NMR spectra were obtained from FX 90 Q Jeol type spectrometer (at 90 MHz) using TMS as an internal reference. Mass spectra (m/s) were recorded on a Jeol JMS-D-300 spectrometer.



SCHEME

Synthesis of O, O diphenyl O-(methyl benzimidazolyl - 2) phosphoro thioate 4a

To the ice cold solution of 2-(hydroxy methyl) benzimidazole (0.001 mol; 0.148 gm) in dry acetone (30 ml) and potassium hydrogen carbonate (0.300 gm), thiophosphorylchloride (0.001 mol; 0.104 gm) in dry acetone (30 ml) was added dropwise in a nitrogen flushed three necked round bottom flask equipped with mechanical stirrer, reflux condenser and a rubber septum. After mixing the reactants, stirring was continued for 4 hours at 0°C. Thereafter, to the above reaction mixture sodium phenoxide (0.002 mol; 0.232 gm) was added and the reaction mixture was refluxed further for 16hr with continuous stirring. The solution containing phosphorothioate was filtered through closed sintered funnel to separate sodium and potassium chloride formed during the reaction. The filtrate was reduced to 1/4th of its original volume under reduced pressure. The product formed was separated out from mother liquor as crystalline solid, it was purified and dried over phosphorus pentoxide. All the operations mentioned above were carried out under anhydrous conditions.

			C	H	N	P	S
4a	$C_{20}H_{17}N_2O_3PS$ (m/z) (396)						
		Found %	60.53	4.30	7.86	4.30	8.15
		(Calcd.)	(60.58)	(4.32)	(7.06)	(7.81)	(8.08)

Synthesis of O, O diphenyl O-(ethyl-1-benzimidazolyl - 2) phosphorothioate 4b

It was prepared in the same manner as described for the synthesis of 4a by using 1b in the reaction.

			C	H	N	P	S
4b	$C_{21}H_{19}N_2O_3PS$ (m/z) (410)						
		Found %	61.20	5.17	6.72	7.54	7.81
		(Calcd.)	(61.15)	(5.17)	(6.79)	(7.50)	(7.77)

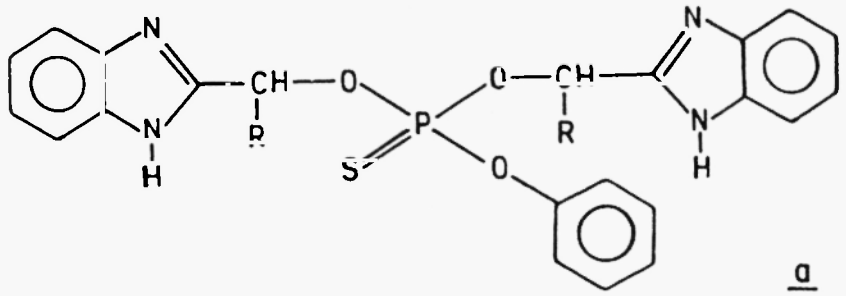
Synthesis of O, O-(4-dinitrophenyl) O-(methyl/ethyl) benzimidazolyl-2) phosphorothioates 5a,b

These derivatives were prepared by the reaction of 1a/b (0.001 mol; 0.148 gm/0.162 gm) in dry acetone (30 ml) and $KHCO_3$ (0.300 gm) with (0.001 mol; 0.148 gm) of thiophosphoryl chloride in dry acetone, according to the procedure described for the synthesis of 4a. After stirring continously for 4 hr at 0°C, sodium nitrophenolate (0.002 mol; 0.322 gm) was added to the reaction mixture and further refluxed for 16 hr with continuous stirring. The product formed was isolated and purified in a similar manner as described for 4a.

5a	$C_{20}H_{15}N_4O_7PS$ (m/z) (486)		C	H	N	P	S
		Found %	49.34	3.17	11.9	6.38	6.62
		(Calcd.)	(49.38)	(3.10)	(11.5)	(6.36)	(6.59)
5b	$C_{21}H_{17}N_4O_7PS$ (m/z) (500)		C	H	N	P	S
		Found %	50.46	3.40	11.7	6.21	6.37
		(Calcd.)	(50.40)	(3.42)	(11.7)	(6.18)	(6.40)

Synthesis of O-phenyl O,O-bis(methyl/ethyl benzimidazolyl-2) phosphorothioates 6a,b

In case of these derivatives,1a/b (0.002 mol; 0.296 gm) reacted with thiophosphoryl chloride (0.001 mol; 0.104 gm) to give O, O-bis-(methyl/ethyl benzimidazolyl-2) phosphorochloridothioate. This in turn reacted with sodium phenoxide (0.001 mol; 0.116 gm) to give 6a,b according to the procedure described for the synthesis of 4a.



6a , b

a R = H

b R = CH_3

6a	$C_{22}H_{19}N_4O_3PS$ (m/z) (450)		C	H	N	P	S
		Found %	65.08	4.69	6.91	7.60	7.92
		(Calcd.)	(65.01)	(4.71)	(6..89)	(7.62)	(7.88)
6b	$C_{24}H_{23}N_4O_3PS$ (m/z) (478)		C	H	N	P	S
		Found %	60.24	4.80	11.7	6.51	6.73
		(Calcd.)	(60.24)	(4.84)	(11.7)	(6.47)	(6.70)

RESULTS AND DISCUSSION

The elemental analyses and the m/z (MS) values of the derivatives 4a,b - 6a,b obtained during the reactions, confirm the composition proposed for the resulting products.

The IR spectra of the derivatives 4a,b - 6a,b showed the absence of frequencies due to P-Cl bond observed at 510-515 cm^{-1} in the spectra of thiophosphoryl chloride. Spectra of these derivatives show strong and intense absorption bands around 800-950 cm^{-1} and 650-700 cm^{-1} corresponding to ν_{as} P=S (I) and (II) respectively. The sharp to medium intensity bands in the region 1010-1030 cm^{-1} and 940-980 cm^{-1} have been assigned to ν_{as} and ν_s P-O-C (alkyl) bond and the absorption band in the region 1455-1460 and 610-630 cm^{-1} to ν P-O-C (aryl) bond respectively. The above mentioned assignments are in accordance with those described for phosphorothioate esters in the literature (13). The absorption bands in the region 3200 and 1420 cm^{-1} are assigned to ν_{as} N-H stretching and δ N-H bending vibrations of -1 N-H group of benzimidazolyl ring (14).

In the ^1H NMR spectra of 2-(hydroxy alkyl) benzimidazoles the broad singlet of -OH proton observed in the region (δ 5.6-5.9 ppm) disappears completely, whereas the singlet of -NH proton of the imidazolyl ring remain almost at the same position (δ 9.0-9.3 ppm) in the spectra of derivatives 4a,b-6a,b. In case of derivatives 4a, 5a and 6a - CH_2

protons gives a doublet in the range (δ 2.8-3.4 ppm, J=6.0 Hz), while in 4b,5b and 6b the -CH proton appears as a multiplet in the region (δ 3.3-3.7 ppm, J=8.0 Hz) and $-CH_3$ proton, gives a doublet of doublet in the region (δ 1.8-2.0 ppm, J = 6.8 Hz) respectively. Multiplet of aromatic protons appear at (δ 6.8-8.2 ppm). Protons of (4-nitro phenyl) moiety in the derivative 5a,b appears in the same region as described for other aromatic protons.

Evaluation of insecticidal activity

Insecticidal studies were carried out against *Periplanata americana*. The percentage mortality was determined by topical and contact method. The result of these studies are given in the (Table - 1).

Table 1

Compound	Colour	Yield %	M.P. °C	Rf value	Percentage mortality for various concentrations, hours			
					0.005%		0.001%	
					48 hrs	72 hrs	48 hrs	72 hrs
4a	Light orange crystals	80	110	0.58	60.0	75.0	70.0	80.0
4b	Dark pink shining crystals	85	114	0.60	70.0	80.0	90.0	95.0
5a	Orange needles	60	112	0.68	65.0	70.0	62.0	78.0
5b	Brown shining crystals	80	118	0.63	75.0	100.0	65.0	90.0
6a	Light brown crystals	75	109	0.55	67.0	82.0	65.0	75.0
6b	Dark pinkish	85	120	0.65	60.0	78.0	75.0	95.0

CONCLUSIONS

All the synthesized compounds were obtained in pure form and as a high melting coloured solids. The spectral data (IR, NMR and mass spectral studies) are in good agreement with analytical studies and hence support the proposed structure. The compounds possess moderate insecticidal activity.

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