

Structure and Fungicidal Activity of Some Diorganotin(IV) with 2-Thioacetic-5-Phenyl-1,3,4-Oxadiazole and Benzamidophenylalanine

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ABSTRACT: *New diorganotin(IV) complexes of the type Ph_2SnL_2 , Bu_2SnL_2 and Me_2SnL_2 of the ligands 2-thioacetic-5-phenyl-1,3,4-oxadiazole (HL^1) and benzamidophenylalanine (HL^2). Have been synthesized and characterized by physico-chemical techniques such as (elemental analysis, and electrolytic conductance) and spectral UV-Visible, IR and 1H , ^{13}C and ^{119}Sn NMR). Monomer structures for the complexes, bidentate and octahedral geometry was proposed for the prepared complexes. Preliminary in vitro tests for fungicidal activity show that all prepared compounds display good fungicidal activity to *Gibberella*, *Cercospora arachidicola*, *Physalospora pircicola* and *Fusarium oxysporum*. Moreover, the $Ph_2Sn(L^2)_2$ shows a higher fungicide activity than diorganotin carboxylate.*

KEY WORDS: *Diorganotin(IV), Carboxylate, Spectral studies, Fungicidal activity.*

INTRODUCTION

The interest in organotin compounds in general and organotin carboxylates in particular continues to grow because of their biological activity and its being introduced there compounds as potential antineoplastic and antituberculosis agents [1-3], PVC stabilizers [4-6] and anti-tumour drugs [7] as well a polymer catalysts [8].

Vast studies have been focused on organotin carboxylates and many of them have been characterized recently either by single crystal structure determination or by different spectroscopic techniques [9].

This paper describe the preparation and characterization

of 2-thioacetic-5-phenyl-1,3,4-oxadiazole (HL^1) and its complexes, diphenyltin(IV) bis(2-thioacetic-5-phenyl-1,3,4-oxadiazole) $Ph_2Sn(L^1)_2$, dibutyltin(IV) bis(2-thioacetic-5-phenyl-1,3,4-oxadiazole) $Bu_2Sn(L^1)_2$ and dimethyltin(IV) bis(2-thioacetic-5-phenyl-1,3,4-oxadiazole) $Me_2Sn(L^1)_2$. In addition the preparation and characterization of benzamidophenylalanine (HL^2) and its complexes, diphenyltin(IV) bis(benzamidophenylalanine) $Ph_2Sn(L^2)_2$, dibutyltin(IV) bis(benzamidophenylalanine) $Bu_2Sn(L^2)_2$ and Dimethyltin(IV) bis(benzamidophenylalanine) $Me_2Sn(L^2)_2$.

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EXPERIMENTAL SECTION

Synthesis of 2-thioacetic -5-phenyl-1,3,4-oxadiazole(HL¹)

A mixture of ethyl benzoate (0.1 mole) and hydrazine hydrate (0.1 mole) was refluxed for two hours, ethanol (50 mL) was added and refluxed for 5 h. The precipitate benzoyl hydrazine which separated on cooling was filtered and washed with cold methanol. To a solution of benzoyl hydrazine (0.02 mole) in ethanol 100mL at 0°C were added carbon disulfide (0.04mol) and potassium hydroxide (0.02 mole) the mixture was refluxed for 7 h. The solvent was evaporated and the residue dissolved in water and acidified with dilute hydrochloric acid. The precipitate was filtered and crystallized from (ethanol) to give 2-mercapto-5-phenyl 1,3,4-oxadiazole which react with one equivalent of chloroacetic acid in presence of KOH as a basic media to give 2-thioacetic-5-phenyl-1,3,4-oxadiazole.the final product was recrystallized from methanol (yield 82%).

Synthesis of benzamidophenylalanine(HL²)

One gram of phenylalanine was dissolved in (25mL) of 5% NaOH solution in a conical flask. To this mixture benzoyl chloride (2.25mL) was added in a five portions in (0.49 mL increments) and shaken vigorously until all the chloride has reacted. Acidified with diluted hydrochloric acid and the crude product was washed with cold ether. Finally, the desired product was recrystallized from ethanol.

Preparation of Complexes

Complexes were synthesized by dissolving the free ligand (2 mmol) in hot toluene and adding the diorganotin oxide (1 mmol) to the solution. The solution was refluxed for 6 hours with magnetic stirrer and then cooled and filtered. The filtrate was reduced under vacuum to a small volume and solid was precipitated by the added of petroleum ether, dried at 60 °C and recrystallized from Ethanol.

Instrumentation

Elemental C, H and N analysis were carried out on a Fison EA 1108 analyzer, the FTIR spectra in the range (4000-370) cm⁻¹ cut were recorded as potassium bromide discs using a Perkin-Elmer spectrophotometer GX, molar conductance measurements were made in anhydrous DMF at 25 °C using Inolop-Cond Level 1 WTW, atomic absorption measurements of the prepared

complexes were obtained using Shimadzu 680cc-flame.The ¹H, ¹³C and ¹¹⁹Sn nuclear magnetic resonance spectra were recorded on a jeol 400 MHz spectrometer, relative to the internal standard TetraMethylSilane (TMS). Melting points were determined in open capillary tubes using an electrothermal 9300 digital melting point apparatus.

RESULTS AND DISCUSSION

Table 1 shows the physical data for the ligand and the prepared complexes. The purity of the ligand and its complexes were checked by TLC using silica gel-G as adsorbent. The conductance of these complexes has been recorded in DMF at room temperature in the range 9-19 ohm⁻¹ cm² mol⁻¹, suggesting their non-electrolytic nature. The data of CHNS and Tin analysis were obtained using flame atomic absorption technique. The calculated values were in a good agreement with the experimental values.

Infra-Red Spectroscopy

The FTIR spectrum for HL¹, shows a characteristic stretching absorption bands at 3468 cm⁻¹, 1633 cm⁻¹, 1315 cm⁻¹,1606 cm⁻¹, 1187 cm⁻¹ and 1066 cm⁻¹ assigned to hydroxyl group, $\nu(\text{COO})$ asym., $\nu(\text{COO})$ sym., C=N of the oxadiazole ring, asymmetrical C-O-C, symmetrical C-O-C stretching respectively.

The FTIR spectrum of the HL², shows a characteristic stretching absorption bands at 3688 cm⁻¹, 3326 cm⁻¹, 1623 cm⁻¹ and 1344 cm⁻¹ assigned to $\nu(\text{OH})$, $\nu(\text{N-H})$, $\nu(\text{COO})$ asym. And $\nu(\text{COO})$ sym. group respectively.

The COO stretching vibrations are important to predict the bonding mode of the ligand. According to *Lebl et al.* [10] the values of $\Delta\nu$ [$\Delta\nu = \nu$ asym. (COO) - ν sym.(COO)] can be divided into 3 groups ; (a) In compounds where $\Delta\nu(\text{COO}) > 350$ cm⁻¹, the carboxylate group binds in a monodentate fashion. However, other very weak intra- and intermolecular interactions can not be excluded. (b) When $\Delta\nu(\text{COO}) < 200$ cm⁻¹, the carboxylate groups of these compounds can be considered to be bidentate. (c) In compounds where $\Delta\nu(\text{COO}) > 200$ cm⁻¹ and < 350 cm⁻¹ an intermediate state between monodentate and bidentate (anisobidentate) occurs. It has also been suggested that the $\Delta\nu(\text{COO})$ value in the chelating mode is less than the $\Delta\nu(\text{COO})$ in a bridging mode [11].

Table 1: Physical data for preparation ligands and its complexes.

compound	Color	%Yield	M.P, °C	Found(Calcd.)%			
				C	H	N	Sn
HL ¹	White	84	162-164	50.81 (50.84)	3.43 (3.41)	11.79 (11.86)	-
HL ²	White	90	165-166	71.32 (71.36)	5.56 (5.61)	5.33 (5.20)	-
Ph ₂ Sn(L ¹) ₂	White	78	110-111	50.97 (51.70)	3.76 (3.25)	7.51 (7.54)	8.44 (8.63)
Bu ₂ Sn(L ¹) ₂	White	69	145-147	47.54 (47.81)	2.34 (4.59)	7.10 (7.96)	10.01 (9.12)
Me ₂ Sn(L ¹) ₂	White	84	138-139	42.76 (42.67)	2.27 (3.26)	9.53 (9.05)	10.44 (10.36)
Ph ₂ Sn(L ²) ₂	White	80	110-112	64.98 (65.28)	4.78 (4.73)	3.76 (3.46)	14.56 (14.66)
Bu ₂ Sn(L ²) ₂	White	77	133-135	62.24 (62.43)	6.12 (6.03)	4.01 (3.64)	15.33 (15.43)
Me ₂ Sn(L ²) ₂	White	84	101-103	60.12 (59.58)	4.93 (5.00)	4.11 (4.09)	17.12 (17.32)

Table 2: Characteristic absorption bands of ligands and its complexes (cm⁻¹).

compound	$\nu(\text{O-H})$	$\nu(\text{COO})$ asym	$\nu(\text{COO})$ sym	$\nu(\text{Sn-C})$	$\nu(\text{Sn-O})$	UV (λ)
HL ¹	3468	1633	1351	-	-	205,276
HL ²	3688	1623	1344	-	-	221,265
Ph ₂ Sn(L ¹) ₂	-	1590	1341	570	455	234,285
Bu ₂ Sn(L ¹) ₂	-	1596	1341	554	466	236,289
Me ₂ Sn(L ¹) ₂	-	1594	1345	564	430	224,284
Ph ₂ Sn(L ²) ₂	-	1532	1336	568	445	225,266
Bu ₂ Sn(L ²) ₂	-	1535	1335	553	467	226,278
Me ₂ Sn(L ²) ₂	-	1540	1337	556	451	231,269

From the preceding discussion it is proposed that in the investigated compounds, have chelating-type carboxylates. The disappearance of the hydrogen from hydroxyl group on complexation indicate the complexation is through the oxygen atom. The bands for $\nu(\text{Sn-C})$ and $\nu(\text{Sn-O})$ are assigned in the range of (553-570) and (430-467) cm⁻¹ respectively. The IR data of the complexes are shown in Table 2. The Table lists the stretching frequency (ν) for some of the characteristics groups exhibited by the ligands and its complexes.

The presence of only one Sn-C band indicates that the two R groups are in trans axial position [12]. According to group theoretical predictions the trans- SnO₄C₂ system should exhibit one Sn-O and one Sn-C vibration and the cis isomer two Sn-C and four Sn-O stretching vibrations in the IR spectra [13].

The appearance of one Sn-C and one Sn-O stretching vibration in the IR spectra of the ligand di-alkyletin(IV) complexes suggests that two R groups are in trans configuration. The UV spectrum of the ligand exhibit a bands attributable to the intra-ligand $\pi \rightarrow \pi^*$ transition. These bands shift to longer wavelengths in the spectra of tin complexes.

Nuclear magnetic resonance

The data of proton NMR of the 2-thioacetic-5-phenyl-1,3,4-oxadiazole (HL¹) and its complexes displayed good solubility in DMSO. The proton nuclear magnetic resonance spectral data gave additional support for the composition of the complexes. The observed changes are evidences of complexation had happened because the chemical shift of a compound is heavily depended on

Table 3: ^1H NMR spectral data (δ ,ppm) of the ligand and complexes.

compound	O-H	C-H aromatic	C-(2)H aliphatic
HL ¹	9.58		3.88
HL ²	9.11	7.41-7.85	3.92
Ph ₂ Sn(L ¹) ₂		7.66-7.94	3.32
Bu ₂ Sn(L ¹) ₂		7.57-7.95	3.33
Me ₂ Sn(L ¹) ₂		7.61-7.93	3.34
Ph ₂ Sn(L ²) ₂	-	7.40-7.81	3.81
Bu ₂ Sn(L ²) ₂	-	7.37-7.81	3.87
Me ₂ Sn(L ²) ₂	-	7.36-7.83	3.88

Table 4: ^{13}C NMR spectral data (δ ,ppm) of the ligands and complexes.

compound	C=O acid	C-H aromatic	C-H ₂ aliphatic	$^1\text{H-Sn}$	^{119}Sn
HL ¹	168.15	123.12-131.87	39.69		-
HL ²	179.64	124.41-130.65	41.44		-
Ph ₂ Sn(L ¹) ₂	170.21	122.13-131.88	39.93	124	-425.64
Bu ₂ Sn(L ¹) ₂	170.34	122.26-31.85	39.91	110	-422.25
Me ₂ Sn(L ¹) ₂	170.91	122.24-131.83	39.65	104	-432.64
Ph ₂ Sn(L ²) ₂	175.54	126.13-133.55	42.07	109	-445.22
Bu ₂ Sn(L ²) ₂	174.18	124.43-131.65	42.11	124	-433.22
Me ₂ Sn(L ²) ₂	174.10	127.52-132.87	42.34	103	-431.65

its electronic environment. The spectra also exhibit a singlet -OH peaks at 9.58 ppm due to hydroxyl group.

Ligand (HL²) give a single resonance near δ 8.47 ppm attributable to the N-H proton. The spectra also exhibit a singlet -OH peaks at 9.11 ppm due to hydroxyl group. The hydroxyl resonances is absent in the spectra of the complexes indicating deprotonation and coordination of Tin to the oxygen. There is a small upfield shift of the aromatic protons resonances of the ligand upon chelation with the diorganotin(IV) moiety [14]. The complexes Ph₂SnL₂, Bu₂SnL₂ and Me₂SnL₂ Show additional signals. The methyltin (Sn-CH₃) accure at 1.35, 1.33 and 1.31 ppm as on the sharp singlet at integrates for the protons accompanied by satellites due to the ^1H - ^{119}Sn coupling that corresponds to the hydrogen atom of the methyl protons of the Me-Sn for the Me₂SnL₂. In dibutyltin(IV) complex the butyl protons appears as a multiple and a triplet in the range 1.45-0.89 ppm due -CH₂CH₂CH₂CH₃ group. The aromatic protons in Ph-Sn appears in the range 7.23-7.31 ppm [14].

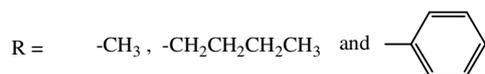
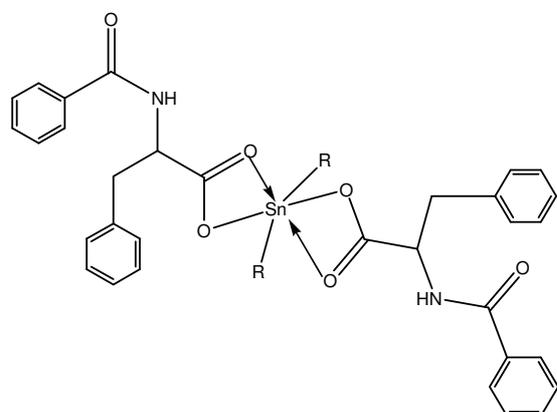
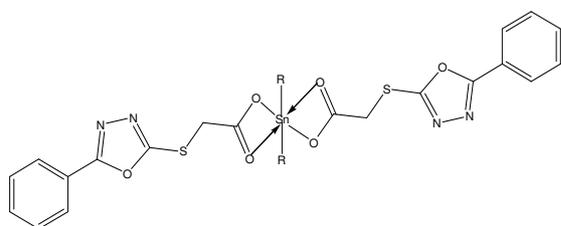
Table 4 shows the most relevant ^{13}C and ^{119}Sn NMR data, their spectra were recorded in [$^2\text{H}_6$] DMSO. The C=O resonance group of the complexes where shifted downfield compared with the position in the free ligand which appeared. It is most likely that shift is due to the decrease of electron density at carbon atoms when oxygen is bonded to metal ion [14].

This observation lends further evidence that the complexation occurred through the oxygen atoms of the carboxylate group. ^{119}Sn NMR and $^1\text{H-Sn}$ spectra for the complexes were recorded in [$^2\text{H}_6$] DMSO. solution are listed in Table 4. The coupling constants observed are of the same order as those reported in the literature chelate tin(IV) derivatives [15]. ^{119}Sn resonance appear, as usual, at lower field region than in Bu₂SnL₂ and Me₂SnL₂ in spite of the greater electron withdrawing capability of the phenyl group. This resonance probably reflects the greater shielding ability of the phenyl group.

Table 5: Fungicidal activities of prepared compounds

compound	<i>Gibberela</i>	<i>Cercospora arachidicola</i>	<i>Physolospira piricola</i>	<i>Fusarium oxysporum</i>
$\text{Ph}_2\text{Sn}(\text{L}^1)_2$	23.4	35.4	84.1	55.4
$\text{Bu}_2\text{Sn}(\text{L}^1)_2$	21.3	33.4	44.5	18.4
$\text{Me}_2\text{Sn}(\text{L}^1)_2$	18.2	23.4	38.1	12.4
$\text{Ph}_2\text{Sn}(\text{L}^2)_2$	22.4	44.3	83.6	70.3
$\text{Bu}_2\text{Sn}(\text{L}^2)_2$	30.2	60.4	80.1	50.4
$\text{Me}_2\text{Sn}(\text{L}^2)_2$	20.4	43.4	50.2	30.5

On the basis of the preceding discussion, the structure of the complexes suggested as follows:



Biological activity

Preliminary *in vitro* tests for fungicidal activity of ligand and complexes have been carried out by the fungi growth inhibition method [16]. These compounds are dissolved in DMF at a concentration of 50 ppm. The data

are summarized in Table 5, and show that all compounds display certain activity to *Physolospira piricola* at a low concentration. Moreover, the Ph_2SnL_2 are more active than the other diorganotin derivatives. In addition, $\text{Ph}_2\text{Sn}(\text{L}^2)_2$ shows the highest inhibition percentage for *Physolospira piricola* (83.6%) *in vitro*.

CONCLUSIONS

The ligands 2-thioacetic-5-phenyl-1,3,4-oxadiazole and benzamidophenylalanine acid was successfully synthesized. The ligand was treated with different diorganotin(IV) salts to afford the corresponding complexes. It may conclude that the ligand coordinated through carboxylate to the Tin atom leading to the formation of four membered ring chelate. Octahedral geometry was proposed for the prepared complexes. Biological activity data have shown that the reported complexes have a significant biological activity against *Gibberela*, *Cercospora arachidicola*, *Physolospira piricola* and *Fusarium oxysporum*.

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REFERENCES

- [1] Tian L., Sun Y., Li H., Zheng X., Cheng Y., Liu X., Qian B., Synthesis, Characterization and Biological Activity of Triorganotin 2-Phenyl-1,2,3-Triazole-4-Carboxylates, *J. Inorg. Biochem.*, **99**, p. 1646 (2005).
- [2] Nathm M., Jairath R., Engb G., Songb X. and Kumarc A., Synthesis, Spectral Characterization and Biological Studies of some Organotin(IV) Complexes of l-Proline, Trans-Hydroxy-l-Proline and l-Glutamine, *Spectrochimica Acta Part A*, **62**, p. 1179(2005).
- [3] Arks E. and Balko D., Thermal Stabilisation of Poly(Vinyl Chloride) by Organotin Compounds. Polymer Degradation and Stability, *Poly. Deg. Stab.*, **88**, p. 46 (2005).
- [4] Thoonen S., Deelman B., Koten G., Aspects of Tetraorganotins and Organotin(IV) Halides, *J. Organomet. Chem.*, **689**, p. 2145 (2004).
- [5] Kuzelova K., Vymazal Z., Contribution to the Study of the Thermal Stabilization of PVC/SAN Blends, *Eur. Polym. J.*, **35**, p. 361 (1999).
- [6] Tabassum S., Pettinari C., Chemical and Biotechnological Developments in Organotin Chemotherapy, *J. Organomet. Chem.*, **691**, p. 1761 (2006).
- [7] Angiolini L., Caretti D., Mazzocchetti L., Salatelli E., Willem R., Biesemans M., Triorganotin-4-Vinylbenzoates: Assessment of their Catalytic Activity in Transesterification Reactions, *J. Organomet. Chem.*, **691**, p. 3043 (2006).
- [8] Katsoulakou E., Tiliakos M., Papaefstathiou G., Terzis A., Raptopoulou C., Geromichalos G., Papazisis K., Papi R., Pantazaki A., Kyriakidis D., Cordopatis P., Zoupa E., Diorganotin(IV) Complexes of Dipeptides Containing the α -Aminoisobutyryl Residue (Aib): Preparation, Structural Characterization, Antibacterial and Antiproliferative Activities of n-Bu)₂Sn(H₁L)] (LH = H-Aib-L-Leu-OH, H-Aib-L-Ala-OH), *J. Inorg. Biochem.*, **102**, p. 1397 (2008).
- [9] Masood H., Ali S., Mazhari M., Shahzad S., Shahidi K., ¹H, ¹³C, ¹¹⁹Sn NMR, Mass, Mossbauer and Biological Studies of Tri-,Di- and Chlorodiorganotin(IV) Carboxylates *Turk. J. Chem.*, **28**, p. 75 (2004).
- [10] Lebl T., Holecek J., Lycka A., Synthesis, Characterization and Biological Activity of Triorganotin 2-Phenyl-1,2,3-Triazole-4-Carboxylates, *Pap. Unv. Pardubice Ser.*, **A2**, p. 5 (1996).
- [11] Bhatti M., Ali S., Huma F., Shahzadi S., Organotin(IV) Derivatives of N-Maleoylamino Acids: Their Synthesis and Structural Elucidation, *Turk. J. Chem.*, **29**, p. 463 (2005).
- [12] Shahid S., Ali S., Hussain M., Mazhar M., Mahmood S., Rehman S., Synthesis, Characterization and Thermal Analysis of Organotin(IV) Derivatives of 4-(N-Maleoyl) Butanoate, *Turk. J. Chem.*, **26**, p. 589 (2002).
- [13] Abdellah M., Hadjikakou S., Hadjiliadis N, Kubicki M., Bakas T, Kourkoumelis N., Simos Y., Karkabounas S., Barsan M., Butler I. Synthesis, Characterization, and Biological Studies of Organotin(IV) Derivatives with o- or p-hydroxybenzoic Acids, *Bioin. Chem. App.* **2009**, p. 1, (2009).
- [14] Najeeb D., Shalan N., Ibraheem H., Farina Y., Yousif E., Synthesis and Fungicidal Activity of Some Diorganotin(IV) with Benzamidocysteine, *J. Al-Nahrain Univ. Sci.* **12(1)**, p. 24 (2009).
- [15] B. Wrackmeyer B., Annual Report, *NMR Spectrosc.*, **16**, 73(1985).
- [16] Zhang X. Yan, Song H., Li Q., Liu X. and Tang L., Synthesis, Structure and Biological Activity of Organotin Derivatives with Pyridylmethylthiobenzoic Acid, *Polyhedron*, **26**, p. 3743 (2007).