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Antibacterial Activity of Diorganotin(IV) Complexes of Some Schiff-Base Derivatives

LUAY J. RASHAN†, ASMA'A A. AZIZ†, KUTHER D. SULAYMAN†,
TALAL A.K. AL-ALLAF* and MANAL A. AL-SHAMA'A‡
Department of Chemistry
College of Science, Applied Science University, Amman-11931, Jordan

The antibacterial activity of thirteen diorganotin(IV) complexes of the general formula $R_2SnCl_2 \cdot L$, where R = Me, Bu, Ph and L = Schiff-bases derived from substituted and non-substituted 2- or 3-aminopyridine and 2-hydroxy or 2-hydroxy-3-methoxy benzaldehyde, have been examined *in vitro* against eight species of bacteria. Some of the complexes obtained showed a remarkable activity towards *S. typhimurium*, while others displayed a significant activity against *P. aeruginosa*, at concentrations ranging between 0.1–10 μg/mL, when compared with that of the antibiotics used in this study, amoxicillin and chloramphenicol and the control (DMSO), where no activity was obtained.

INTRODUCTION

Wide range of biological properties have been recently found in the literature to be associated with some tin metal complexes of nitrogen containing ligands, including antibacterial and antitumour activities,[1–5] as well as fungicidal, bactericidal, herbicidal, acaricidal, antifeedant, . . . etc activities in agriculture.[6]

In a short communication, we have given a brief information about our findings on the antibacterial activity of some diorganotin(IV) dichloride complexes of a number of Schiff-base derivatives.[7] As a continuation of our fruitful findings on the biological evaluation of organotin(IV) complexes, with various donor ligands, against bacteria[8] and tumours[9], we have given in the present work a detailed description of the antibacterial activity of thirteen diorganotin(IV) complexes of the general formula $R_2SnCl_2 \cdot L$ (Scheme 1) against eight bacterial species.[7]

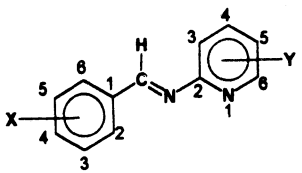
EXPERIMENTAL

The starting material Bu_2SnCl_2 is a commercial product, Me_2SnCl_2 and Ph_2SnCl_2 were prepared by standard methods.[8, 9] The Schiff-bases (I_{a-d}–IV) were prepared in our laboratories.[10]

The diorganotin(IV) complexes $R_2SnCl_2 \cdot L$, R = Me, Bu, Ph; L = Schiff-bases I_{a-d}–IV (Scheme 1) were prepared by treating equimolar quantities of R_2SnCl_2

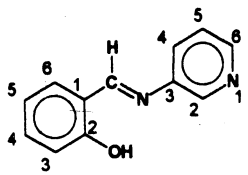
†Department of Biology, College of Education, University of Mosul, Iraq.
‡Department of Basic Science, College of Agriculture and Forestry, University of Mosul, Iraq.

SCHEME 1
THE SCHIFF-BASE DERIVATIVES (I_{a-d}–IV) AND THEIR R_2SnCl_2 COMPLEXES USED IN THIS STUDY

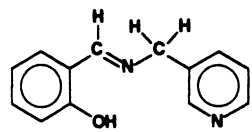


(I)

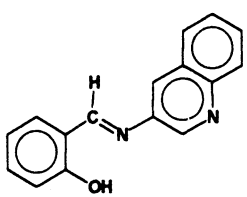
Ia. X = 2-OH. Y = H
Ib. X = 2-OH ,3-OCH_3. Y = H
Ic. X = 2-OH. Y = 3-CH_3
Id. X = 2-OH. Y = 4-CH_3



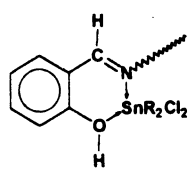
(II)



(III)



(IV)



R_2SnCl_2.(I-IV) Complexes

and the Schiff-base derivative in dry chloroform at ambient temperature or under reflux, depending on the nature of the tin compound used, for *ca.* 30 min. The product was precipitated with ether, after removal of some chloroform from the reaction mixture, and purified by successive recrystallization from chloroform/ether before being used for antibacterial evaluation. The complexes were dried under vacuum at 60°C for several hours. They were characterized by their melting points, IR, ^1H and ^{13}C spectroscopy, and their C, H, N elemental analyses.[11]

Biological studies: The bacterial species used in this study are listed in Table-1. All strains were obtained from Pasteur Institute (Paris). They were grown up to the stationary phase in a nutrient broth at 37°C and a sample of 0.5 mL of each bacterium was spread over a surface of a nutrient agar plate.[12]

Antibacterial assay: Discs of filter paper, 6 mm in diameter, were sterilized at 140°C for 1 h and impregnated with 1 mL of stock solutions of 10 μg/mL of each tin complex and then dried. Dimethylsulphoxide(DMSO) was used as a solvent for these complexes. Three separate sets of control containing the tin complex, solvent and the antibiotics (amoxicillin and chloramphenicol) were used. The inoculated plates were incubated at 37°C for 18 h and the inhibition zones were measured. In all the experiments the mean of each triplicate was measured.

RESULTS AND DISCUSSION

The diorganotin(IV) dichloride complexes R_2SnCl_2·L, R = Me, Bu, Ph and L

TABLE-1
THE ANTIBACTERIAL ACTIVITY OF R_2SnCl_2·L, R = Me, Bu, Ph and L = SCHIFF-BASES I_{a-b}·IV

Complex	Diameter of inhibition zone (mm)																											
	S. aureus				*B. subtilis*				E. coli				P. vulgaris				K. peneumonia				P. aeruginosa				S. typhimurium				S. flexneri			
	10*	1.0*	0.1*	0.01*	10	1.0	0.1	0.01	10	1.0	0.1	0.01	10	1.0	0.1	0.01	10	1.0	0.1	0.01	10	1.0	0.1	0.01	10	1.0	0.1	0.01	10	1.0	0.1	0.01
$Me_2SnCl_2·I_a$†	10	8	7	—	12	9	6	—	12	10	8	—	12	10	8	—	—	—	—	—	27	23	15	—	—	—	—	—	10	8	7	—
$Ph_2SnCl_2·I_a$	17	14	12	10	14	12	9	—	11	10	7	—	10	8	—	—	10	8	—	—	12	10	9	0.7	13	10	8	—	10	9	7	—
$Bu_2SnCl_2·I_b$	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9	8	7	—	—	—	—	—	—	—	—	—
$Pe_2SnCl_2·I_b$†	20	15	15	10	14	11	10	7	12	10	—	—	9	6	—	—	—	—	—	—	—	—	—	—	10	10	7	—	‡	‡	‡	‡
$Ph_2SnCl_2·I_c$	20	17	14	11	14	10	8	—	10	8	7	—	11	9	8	—	10	8	7	—	21	16	12	—	13	10	8	—	12	10	7	—
$Bu_2SnCl_2·I_d$	15	13	9	—	16	14	8	—	11	9	—	—	10	8	—	—	10	8	—	—	8	—	—	—	15	12	7	—	10	8	—	—
$Me_2SnCl_2·II$	10	9	7	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9	8	7	—
$Bu_2SnCl_2·II$†	12	11	9	—	18	13	9	—	10	9	—	—	13	12	10	7	14	11	—	—	13	11	10	—	15	12	8	—	15	11	—	—
$Ph_2SnCl_2·II$	15	15	11	9	16	14	8	—	13	10	—	—	12	10	8	—	9	7	—	—	17	12	—	—	10	—	—	—	12	9	—	—
$Me_2SnCl_2·III$	12	9	—	—	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9	—	—	—	—	—	—	—
$Ph_2SnCl_2·III$	15	15	12	8	15	12	12	10	11	9	—	—	10	8	—	—	9	7	5	—	—	—	—	—	11	10	6	—	‡	‡	‡	‡
$Me_2SnCl_2·IV$	10	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13	10	—	—	—	—	—	—	—	—	—	—
$Ph_2SnCl_2·IV$†	23	18	15	12	14	10	14	10	9	7	—	—	10	8	7	—	8	7	—	—	23	16	13	—	13	11	8	—	13	10	8	—
Amoxicillin	30	25	13	—	18	14	18	14	25	15	—	—	14	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	35	25	15	—
Chloramphenicol	20	14	6	2	19	12	19	12	24	14	3	—	3	2	2	—	25	15	—	—	7	3	2	—	—	—	—	—	20	14	5	—
Control (DMSO)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

*Concentrations are in µg/mL †Data taken from our previous work and added here for comparison ‡Not tested

= Schiff-bases I_{a-d}–IV (Scheme 1) were prepared, purified and characterized as described in the experimental part. The effects of the diorganotin(IV) dichloride complexes together with the antibiotics (amoxicillin and chloramphenicol) on eight species of bacteria in a nutrient agar are shown in Table-1. All the compounds used in the present study were found to show a considerable activity or a broad spectrum of activity towards the bacterial species used. However, in comparing this activity with the antibiotics used, it appears that the most promising results in the present study are those for the complexes of Ph_2SnCl_2 with ligands I_{a-c}, III, IV and the complexes of Bu_2SnCl_2 with the ligands I_d, II (Table-1). These exhibited a remarkable activity against *S. typhimurium* at nearly all the concentrations used (zone of inhibition ranging from 6–15 mm), in comparison with those of the reference standards (amoxicillin and chloramphenicol) and control (DMSO) where no inhibition zones were obtained. Moreover, the complexes $Me_2SnCl_2{\cdot}I_a$, $Me_2SnCl_2{\cdot}$IV, $Bu_2SnCl_2{\cdot}$II, $Ph_2SnCl_2{\cdot}I_a$, $Ph_2SnCl_2{\cdot}I_c$, $Ph_2SnCl_2{\cdot}$II and $Ph_2SnCl_2{\cdot}$IV (Table-1) showed a significant activity against *P. aeruginosa* at most of the concentrations applied (zone of inhibition ranging from 7–27 mm), in comparison with that of chloramphenicol (zone of inhibition ranging from 2–7 mm) and amoxicillin and control (no inhibition zone).

The present results are preliminary, however encouraging; yet it is premature at this stage to discuss the significance of these results without knowing the mechanisms of action of these complexes.

The findings of such complexes with a significant antibacterial activity are interesting. Therefore, subsequent studies with further description of other biological activities are in progress at our laboratories.

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