

NOTES

TABLE I—ANALYTICAL AND PHYSICAL DATA

Compd. no.	Yield %	M.p. °C	Molecular formula	Analysis % Found/(Calcd.) N	ν_{\max} cm^{-1}	DNP, m p °C
1	91	124	$\text{C}_9\text{H}_9\text{ON}_2$	7.00 (7.10)	1 165	191
2	66.9	115	$\text{C}_{17}\text{H}_{15}\text{O}_2\text{N}_2$	6.52 (6.82)	1 665	195
3	82	105	$\text{C}_{10}\text{H}_9\text{OBrN}_2$	6.01 (6.10)	1 660	207
4	72	126	$\text{C}_{16}\text{H}_{15}\text{OCIN}_2$	6.44 (6.76)	1 655	179
5	66	Thin syrupy liquid	$\text{DNP-C}_{10}\text{H}_{10}\text{O}_4\text{N}_2$	15.84 (15.96)	1 655	156
6	66	Thin syrupy liquid	$\text{DNP-C}_{11}\text{H}_{11}\text{O}_4\text{N}_2$	15.03 (15.16)	1 660	193
7	80	124 ^c	$\text{C}_{10}\text{H}_9\text{ON}_2$	7.01 (7.38)	1 660	189
8	65	100	$\text{C}_{11}\text{H}_{11}\text{O}_2\text{N}_2$	9.98 (10.21)	1 660	149
9	68	105	$\text{C}_{11}\text{H}_{11}\text{ON}_2$	7.26 (7.65)	1 660	120
10	89	96	$\text{C}_{11}\text{H}_{11}\text{O}_2\text{N}_2$	6.85 (7.07)	1 665	210
11	76	134	$\text{C}_{10}\text{H}_{11}\text{ON}_2$	7.01 (7.36)	1 650	178
12	69	102	$\text{C}_{10}\text{H}_{11}\text{ON}$	— (4.77)	1 650	104
13	79	Thin syrupy liquid	$\text{DNP-C}_{11}\text{H}_{11}\text{O}_4\text{N}_2$	15.02 (15.25)	1 665	205
14	88	Thin syrupy liquid	$\text{DNP-C}_{11}\text{H}_{11}\text{O}_4\text{N}_2$	16.11 (16.47)	1 660	210
15	92	173	$\text{C}_{16}\text{H}_{15}\text{NO}_2\text{Br}^a$	3.20 (3.70)	1 650	Semi 194
16	81	176	$\text{C}_{15}\text{H}_{15}\text{O}_2\text{Br}_2^b$	—	1 670	232
17	78	174	$\text{C}_{15}\text{H}_{15}\text{O}_2\text{ClBr}_2^c$	—	1 655	Semi 193
18	86	158	$\text{C}_{15}\text{H}_{15}\text{O}_2\text{Br}_2^d$	—	1 660	241
19	82	171	$\text{C}_{15}\text{H}_{15}\text{O}_2\text{Br}_2^e$	—	1 650	202
20	81	188	$\text{C}_{15}\text{H}_{15}\text{O}_2\text{Br}^f$	—	1 660	160

^a Br, 20.98 (21.16). ^b C, 46.01 (46.60), H, 2.34 (2.91); Br, 38.12 (38.89). ^c C, 69.98 (70.31); H, 3.02 (3.51); Cl, 13.12 (13.67). ^d C, 80.98 (81.08); H, 4.03 (4.50). ^e C, 59.41 (59.80); H, 2.19 (2.99); Br 26.18 (26.57). ^f C, 57.12 (57.65), H, 3.06 (3.90); Br, 23.89 (24.02).

Acknowledgement

The authors are thankful to the State C.S.I.R., U.P., for providing necessary grant and a Junior Research Fellowship to one of them, and to the Principal, Agra College, for providing facilities.

Synthesis and Antifungal Activity of Thiazolidinones

MANGAT RAI*, B. S. DHIR and P. S. KALSI

Department of Chemistry, Punjab Agricultural University, Ludhiana-141 004

and

R. C. SHARMA and J. S. JHOOTY

Department of Plant Pathology, Punjab Agricultural University Ludhiana-141 004

Manuscript received 12 October 1984, revised 30 August 1985, accepted 18 June 1986

References

1. CLAISEN, *Chem. Ber.*, 1881, **14**, 2471.
2. W. E. BARTHEL, N. GREEN, I. KRISER and L. F. STEINER, *Science*, 1957, **126**, 654, C. W. SABROSTY, U. S. Dept. Agr., Entomol. Research Div., Private Communication, 1957, S. L. ALLMAN, Dept. of Agr., Sydney, New South Wales, Australia, Private Communication, 1957.
3. D. SCHNEIDER and Z. VERGLEICH, *Physiol.*, 1957, **40**, 841, S. H. HUTNER, H. M. KAPLAN and E. V. ENZMANN, *Am. Naturalist*, 1937, **71**, 575.

4-Thiazolidinones have been reported to possess antifungal activity¹⁻³. The presence of hydroxy-substituted phenyl group is shown to increase the activity of the parent compound^{4,5}. Here the synthesis of 4-thiazolidinones from 4-hydroxybenzal-anilines and 4-hydroxy-3-methoxybenzal-anilines^{1,6} and evaluation of the products as fungicides are reported.

Reaction of thioglycolic acid (2) with 4-hydroxybenzal-anilines and 4-hydroxy-3-methoxybenzal-anilines (1) under Surrey's experimental conditions^{1,7}

resulted in the formation of thick oils (perhaps due to polymerisation at high temperature) which failed to crystallise. The method was modified to provide crystalline products. These products have been identified and confirmed as 2-(substituted-phenyl)-3-(substituted-phenyl)-4-thiazolidinones (4) on the basis of elemental analysis, ir and nmr spectral studies.

The ir spectra of the adducts (4) showed bands at 1740 cm⁻¹ (C=O). The nmr spectrum of 2-(*m*-methoxy-*p*-hydroxyphenyl)-3-phenyl-4-thiazolidinone (4a) showed phenolic proton at τ 1.5 as a singlet, eight aromatic protons at 2.4–2.7 as a multiplet, three methoxy protons as a singlet at 6.1, two methylene protons as a singlet at 7.1 and one proton on the C-2 of the thiazolidinone ring at 2.2. The various 4-thiazolidinones synthesised by the condensation of thioglycolic acid with 4-hydroxybenzalanilines and 4-hydroxy-3-methoxybenzalanilines are recorded in Table 1.

TABLE 1—CHARACTERISTICS OF 4-THIAZOLIDINONES

Compd. no.	R	R'	M.p.* °C	Yield %	Molecular formula**
4a	H	H	129	83	C ₁₆ H ₁₆ NSO ₂
4b	H	<i>p</i> -OCH ₃	169	80	C ₁₇ H ₁₇ NSO ₂
4c	H	<i>p</i> -OC ₂ H ₅	185	80	C ₁₈ H ₁₈ NSO ₂
4d	H	<i>p</i> -Cl	183	72	C ₁₆ H ₁₄ ClNSO ₂
4e	OCH ₃	H	124	80	C ₁₇ H ₁₇ NSO ₂
4f	OCH ₃	<i>p</i> -OCH ₃	125	80	C ₁₈ H ₁₈ NSO ₂
4g	OCH ₃	<i>p</i> -OC ₂ H ₅	116	75	C ₁₉ H ₁₉ NSO ₂
4h	OCH ₃	<i>p</i> -Cl	73	70	C ₁₇ H ₁₅ ClNSO ₂

* Uncorrected. ** All the compounds gave satisfactory elemental analysis.

The newly synthesised 4-thiazolidinones (4a–h) have been tested against *Alternaria solani*, *Fusarium* sp., *Colletotrichum capici*, *Aspergillus* sp. and *Helimithosporium* sp. by employing the method of spore germination inhibition. Three concentrations, viz. 1 000, 500 and 250 ppm of each of the compounds have been tried against all the test fungi. A study of the data (Table 2) showed that all the 4-thiazolidinones possessed antifungal

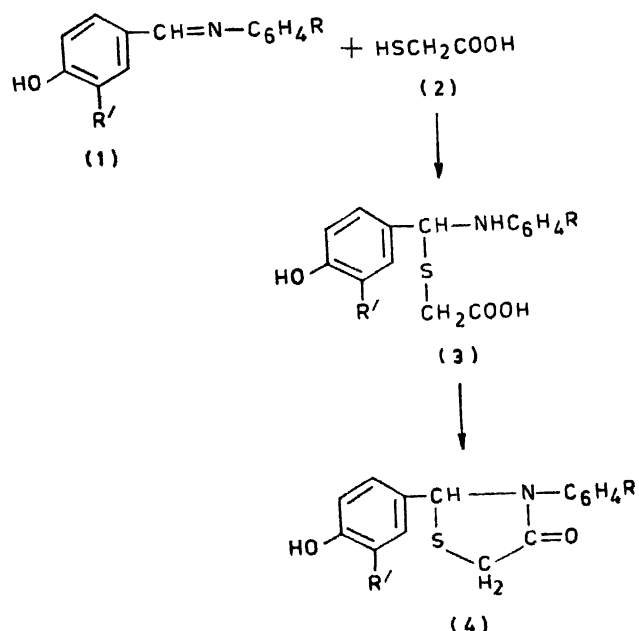
TABLE 2—ANTIFUNGAL ACTIVITY OF 4 THIAZOLIDINONES

Compd. no.	Concn. ppm	% spore germination inhibition				
		<i>A. solani</i>	<i>C. capici</i>	<i>F. sp.</i>	<i>A. sp.</i>	<i>H. sp.</i>
4a	1 000	100.00	100.00	100.00	100.00	18.18
	500	73.50	100.00	38.88	10.00	8.08
	250	15.90	38.70	8.08	4.44	1.01
4b	1 000	10.20	23.46	57.57	100.00	6.06
	500	7.14	8.16	48.99	100.00	2.02
	250	4.03	0.00	31.31	100.00	1.01
4c	1 000	5.10	18.96	47.98	43.33	48.48
	500	4.08	0.00	26.26	30.01	38.38
	250	2.04	1.02	6.06	31.11	1.01
4d	1 000	83.67	45.92	89.39	100.00	100.00
	500	6.63	2.55	51.52	88.33	23.23
	250	4.03	1.02	24.24	83.88	11.11
4e	1 000	100.00	100.00	100.00	100.00	100.00
	500	100.00	100.00	100.00	100.00	100.00
	250	67.86	12.24	83.35	43.33	100.00

(Table 2 contd.)

4f	1 000	4.59	40.82	55.05	22.22	21.21
	500	3.06	16.84	32.83	17.77	8.08
	250	5.10	2.04	28.79	17.77	0.00
4g	1 000	3.06	48.98	49.49	13.13	100.00
	500	2.04	25.51	38.89	15.15	50.50
	250	3.57	13.77	27.27	12.22	5.05
4h	1 000	48.98	4.08	53.53	40.00	100.00
	500	27.55	4.59	28.79	40.00	15.15
	250	8.16	2.04	11.11	37.77	3.03

activity. Compounds 4a and 4e caused 100% spore germination inhibition at 1 000 ppm of above fungi. The other two concentrations (500 and 250 ppm) of these compounds were also effective. Another interesting conclusion of this study is that the parent compound has the maximum antifungal activity. Among the substituted-4-thiazolidinones, chloro-substituted are more effective than the methoxy- or ethoxy-substituted-thiazolidinones.



- 4 a, R=H, R'=H
- b, R=H, R'=*p*-OCH₃
- c, R=H, R'=*p*-OC₂H₅
- d, R=H, R'=*p*-Cl
- e, R=OCH₃, R'=H
- f, R=OCH₃, R'=*p*-OCH₃
- g, R=OCH₃, R'=*p*-OC₂H₅
- h, R=OCH₃, R'=*p*-Cl

Experimental

The following general method was used for the synthesis of 4-thiazolidinones. 3-Methoxy-4-hydroxybenzalaniline (0.01 mol) was dissolved in dry benzene (25 ml). To it was added thioglycolic acid (0.01 mol) taken in benzene (10 ml) slowly and with constant shaking at room temperature. After the addition of thioglycolic acid was complete, water formed during the reaction was removed by

adding anhydrous sodium sulphate. Removal of the solvent under vacuum gave the crude product which was purified by crystallisation from benzene to obtain fine crystals of 2-(4-hydroxy-3-methoxy)-3-phenyl-4-thiazolidinone (4a; 80%), m. p. 124° (Found: C, 63.82; H, 4.95; N, 4.59; S, 10.63. $C_{16}H_{15}NSO_3$, calculated for: C, 63.77; H, 4.98; N, 4.65; S, 10.63%).

References

1. J. KINUGAWA and K. NEGASE, *Chem. Abstr.*, 1965, 63, 5658.
2. R. R. SHAH, R. D. MEHTA and A. R. PARIKH, *J. Indian Chem. Soc.*, 1981, 58, 1113.
3. H. K. SHUKLA, R. R. ASTIK and K. A. THAKER, *J. Indian Chem. Soc.*, 1981, 58, 1182.
4. B. DASH, S. PRAHARAJ and P. K. MOHAPATRA, *J. Indian Chem. Soc.*, 1981, 58, 1184.
5. S. S. MEHER, S. NAIK, R. K. BEHERA and A. NAYAK, *J. Indian Chem. Soc.*, 1981, 58, 274.
6. S. N. DEHURI and A. NAYAK, *J. Indian Chem. Soc.*, 1983, 60, 970.
7. N. C. DESAI, R. R. ASTIK and K. A. THAKER, *J. Indian Chem. Soc.*, 1982, 59, 771.
8. S. DEVI, A. NAYAK and A. S. MITTRA, *J. Indian Chem. Soc.*, 1984, 61, 835.
9. S. V. PATEL, G. V. BHANDANI and G. B. JOSHI, *J. Indian Chem. Soc.*, 1984, 61, 372.
10. P. C. JOSHI, JR. and P. C. JOSHI, SR., *J. Indian Chem. Soc.*, 1984, 61, 484.
11. S. V. PATEL, J. N. VASAVADA and G. B. JOSHI, *J. Indian Chem. Soc.*, 1984, 61, 560.
12. K. A. THAKER and A. M. PADHYE, *J. Indian Chem. Soc.*, 1984, 61, 715.
13. R. LAKHAN and O. P. SINGH, *J. Indian Chem. Soc.*, 1984, 61, 784.
14. O. J. BRAENDEN, N. B. EDDY and B. HAACH, *Bull. World Health Org.*, 1955, 13, 935.
15. J. LEE, H. ZIERING, S. D. HEINEMANN and L. BERGER, *J. Org. Chem.*, 1947, 12, 885.
16. A. SINGH, M. RAI and K. K. SINGAL, *Indian J. Chem.*, 1976, 13, 991.
17. A. R. SURREY, *J. Am. Chem. Soc.*, 1947, 69, 2911.

2-Carboxy-2'-hydroxy-5-methylazobenzene as Spectrophotometric Reagent for the Estimation of Nickel(II) and Palladium(II) individually and also from their Binary Mixture

CHANCHAL BANDYOPADHYAY, B. C. ROY

and

M. B. SAHA*

Department of Inorganic and Analytical Chemistry,
Jadavpur University, Calcutta-700 032

Manuscript received 22 July 1985, revised 19 May 1986,
accepted 18 June 1986

AZO compounds have already been utilised for spectrophotometric estimation of metal ions^{1,2,6}. Most of the azo compounds utilised for this purpose are 2-hydroxyazobenzene derivatives¹⁻¹². A few reagents which have analogous complexing

capability like the present reagent are 2-carboxy-2'-hydroxy-3',5'-dimethylazobenzene-4-sulphonic acid⁴, 6-carboxy-3'-methyl-6'-hydroxyazobenzene-4-sulphonic acid¹² and 6-carboxy-6'-hydroxy-3',5'-dichloroazobenzene-4-sulphonic acid¹³. The present paper introduces a new azo compound, viz. 2-carboxy-2'-hydroxy-5'-methylazobenzene for spectrophotometric determination of Ni^{II} and Pd^{II}. Enhanced sensitivity, fewer interferences and easy separability of Ni^{II} and Pd^{II} can claim its superiority. Moreover, it has been found to produce characteristic coloured complex species in solution with other transitional metal ions like Fe^{III}, Co^{II}, Cu^{II}, Ru^{III}, Cr^{III} and Mn^{II} etc., the determinations of which are under investigation. Both Ni^{II} and Pd^{II} form 1:1 complexes with the reagent not only in solution but also in solid state.

Experimental

The reagent 2-carboxy-2'-hydroxy-5'-methylazobenzene was prepared by the method available in literature¹⁵. The reagent solution (1 mg/ml) in absolute ethanol was utilised for experimental investigations. The Ni^{II} and Pd^{II} solutions were made from AnalaR nickel chloride and palladium chloride and standardised by the dimethyl glyoxime method¹⁶. Solutions of diverse ions were prepared from the chloride or nitrate salts of sodium, potassium or ammonium. Absorbance measurements were made with a Spectromom-204 spectrophotometer and pH values were determined with a Elico LI-10 pH meter.

Procedure: The ethanolic solution of the reagent (3.0 ml) were added to Ni^{II} solution (3.0 ml), [M]=0.025 mg/ml and ammonium acetate—ammonia buffer solution (5.0 ml) in a final volume of 25 ml made up with ethanol to maintain the optimum pH 7.85 (within the range 6.0 to 10.0). The λ_{max} of the deep red coloured Ni^{II} complex was ascertained at 485 nm against the reagent blank. The λ_{max} of the Pd complex (5.0 ml reagent 1 mg/ml, 3.0 ml Pd, 0.025 mg/ml containing sufficient acid to maintain pH in the range 1.5–3.8) was found to be 560 nm. The colours remained stable for more than 7 days.

Results and Discussion

In the case of Ni^{II} complex, Beer's law was obeyed within 0.50 to 7.0 ppm of Ni^{II}. The molar absorptivity of the complex and the photometric sensitivity according to Sandell¹⁷ were found to be 8 300 mol⁻¹ cm⁻¹ and 0.006 9 μ g cm⁻², respectively at 485 nm. The corresponding values for Pd^{II} complex were 0.5 to 13.0 ppm, 7 109 mol⁻¹ cm⁻¹ and 0.015 0 μ g cm⁻², respectively at 560 nm. The 1:1 stoichiometry of the complexes formed were ascertained by Job's method of continuous variation¹⁸ and molar ratio method¹⁹.

Effect of diverse ions: Among the cations, anions and complexing agents tartrate, citrate,