thioöxazolidone whereas the carbon disulfide and alkali process of Bruson[2] produces a mixture of the 2-thioöxazolidone and thiazoline compounds. Similarly 2-aminobutanol-1, (I).R = H, R′ = C_2H_5, produces a thioöxazolidone derivative instead of a substituted thiazoline. The reaction products are thus similar to those obtained by the thiuram procedure.[3]

EXPERIMENTAL[5]

Preparation of substituted 2-thioöxazolidone from 2-amino alcohols. A mixture of 1 mole (89.1 g.) 2-aminobutanol-1, or 2-methyl-2-aminopropanol-1, and 90 g. of ammonium hydroxide was cooled in an ice bath at 10° and 76 g. of carbon disulfide were added over a 15-min. period, and then stirred for 1 hr. or until it became a clear uniform solution. A solution prepared by dissolving 94.5 g. (1 mole) of monochloracetic acid in 70 ml. of water and neutralizing with 70 ml. of ammonium hydroxide solution was added to the above dithiocarbamate solution. This reaction was somewhat exothermic and the temperature rose to 20 to 25°. Stirring was continued for an hour after addition was complete and the mixture was then allowed to stand overnight. The white crystals of the substituted 2-thioöxazolidone which formed, were filtered by suction on a Büchner funnel and washed with a small amount of cold water. The yield was 45 to 55 g. of air dried crystals (35–42% of theory).

4-Ethyl-2-thioöxazolidone, (V), R = H; R′ = C_2H_5. The white crystals prepared above from 2-aminobutanol-1 melted at 72.8 to 73.2° after recrystallization from alcohol (lit.,[3] m.p. 74–75°). These crystals were soluble in alcohol, ethyl acetate, benzene, and acetone.

Anal. Calcd. for C_5H_9NOS: C, 45.77; H, 6.91; N, 10.68; S, 24.44. Found: C, 46.06; H, 6.88; N, 10.35; S, 24.56.

4,4-Dimethyl-2-thioöxazolidone, (V), R = R′ = CH_3. When recrystallized from alcohol, the melting point was 124.6 to 125.8° (lit.,[6] m.p. 123–125°). The compound was soluble in alcohol, benzene, and ethyl acetate.

Anal. Calcd. for C_5H_9NOS: C, 45.77; H, 6.91; N, 10.68; S, 24.44. Found: C, 45.96; H, 6.78; N, 9.90; S, 25.04.

RESEARCH DEPARTMENT
VAN AMERINGEN-HAEBLER (A DIVISION OF
INTERNATIONAL FLAVORS & FRAGRANCES INC.)
UNION BEACH, N. J.

(5) Microanalysis by the Clark Microanalytical Laboratory, Urbana, Ill.

(6) C. Y. Hopkins, *Can. J. Research*, **B20**, 268 (1942).

Studies on Hydroxybenzotriazoles

H. SINGH AND R. S. KAPIL[1]

Received October 8, 1959

Several compounds containing the grouping >NOH have been reported[2] to be useful as organic precipitating agents. 1-Hydroxy-1,2,3-benzotriazoles also contain a similar grouping. In view of the fact that they can be prepared readily by the action of sodium hydroxide[3,4j] or hydrazine hydrate on *o*-nitrophenylhydrazines[4] or even from *o*-dinitrobenzenes,[4a,j] it was considered worthwhile to synthesize some additional derivatives and study their analytical behavior.

1-Hydroxy-1,2,3-benzotriazoles have been prepared by the action of hydrazine hydrate on *o*-nitrophenylhydrazines and also on *o*-dinitrobenzenes. They are suitable for the estimation of silver ion with which they give a quantitative precipitate.

Details of their analytical behavior shall be published elsewhere.

(1) Present address: Division of Medicinal Chemistry, Central Drug Research Institute, Lucknow, India.

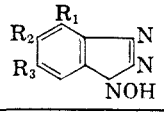
(2) (a) F. Ephriam, *Ber.*, **63**, 1928 (1930). (b) G. Denigs, *Bull. soc. pharm. Bordeaux*, **70**, 101 (1932). (c) D. C. Sen, *J. Indian Chem. Soc.*, **15**, 473 (1938). (d) J. F. Flagg and N. H. Furman, *Ind. Eng. Chem., Anal. Ed.*, **12**, 529 (1940). (e) K. J. Keuning and J. V. Dubsky, *Rec. trav. chim.*, **59**, 978 (1940). (f) P. Wenger, R. Duckert, and M. Busset, *Helv. Chim. Acta*, **24**, 889 (1941).

(3) R. Nietzki and E. Braunschweig, *Ber.*, **27**, 3381 (1894).

(4) (a) T. Curtius and M. Mayer, *J. prakt. Chem.*, **76** (ii), 369 (1907). (b) W. Borsche and D. Rantshew, *Annalen*, **379**, 152 (1911). (c) G. T. Morgan and T. Glover, *J. Chem. Soc.*, **119**, 1700 (1921). (d) O. L. Brady and J. H. Bowman, *J. Chem. Soc.*, **119**, 894 (1921). (e) O. L. Brady and J. N. E. Day, *J. Chem. Soc.*, **123**, 2258 (1923). (f) O. L. Brady and C. V. Reynolds, *J. Chem. Soc.*, 193 (1928); 1273 (1931). (g) E. Müller and W. Hoffmann, *J. prakt. Chem.*, **111**, 293 (1925). (h) E. Müller and G. Zimmermann, *J. prakt. Chem.*, **111**, 277 (1925). (i) E. Müller and K. Weisbrod, *J. prakt. Chem.*, **111**, 307 (1925). (j) S. S. Joshi and D. S. Deorha, *J. Indian Chem. Soc.*, **29**, 545 (1952).

TABLE I

1-HYDROXY-1,2,3-BENZOTRIAZOLES



No.	R_1	R_2	R_3	Formula	Color	M.P.°C	Analysis	
							Calcd.	Found
1	H	Cl	H	$C_6H_4N_3OCl$	Colorless plates	210d[a,b]	Cl: 20.93	20.8
2	H	Br	H	$C_6H_4N_3OBr$	Colorless plates	220d[a]	Br: 37.39	37.2
3	H	I	H	$C_6H_4N_3OI$	Colorless plates	200d[a]	I: 48.66	48.4
4	H	Cl	CH_3	$C_7H_6N_3OCl$	Colorless needles	203d[a]	Cl: 19.34	19.2
5	H	I	CH_3	$C_7H_6N_3OI$	Colorless needles	182[a]	I: 46.18	46.0
6	H	C	Cl	$C_6H_3N_3OCl_2$	Colorless needles	215[a,c]	Cl: 34.81	34.5
7	Br	H	Br	$C_6H_3N_3OBr_2$	Colorless needles	218d[a]	Br: 54.61	54.4

[a] Recrystallized from ethanol. [b] Lit.,[4h] m.p. 204–205°. [c] Lit.,[4g] m.p. 194–196°.

EXPERIMENTAL[5]

5-Bromo-1-hydroxy-1,2,3-benzotriazole. To a solution of 2-nitro-5-bromophenylhydrazine (0.5 g.) in ethanol (20 ml.) was added hydrazine hydrate (2 ml. 50%). It was heated on a water bath for 0.5 hr., concentrated to a small volume, diluted with water and filtered. The filtrate on acidification with dilute hydrochloric acid gave 5-bromo-1-hydroxy-1,2,3-benzotriazole (0.3 g.) as colorless plates from ethanol, m.p. 220° dec. By adopting a similar procedure other hydroxybenzotriazoles were prepared. The data concerning the new compounds are listed in Table I. All of them explode above their melting points.

Acknowledgment The authors wish to express their gratitude to Dr. S. S. Joshi, D.Sc., for his kind interest in this work.

DEPARTMENT OF CHEMISTRY
MEERUT COLLEGE
MEERUT, INDIA

(5) All melting points are uncorrected.

Identification of Caffeic Acid in Cigarette Smoke

CHAO-HWA YANG, Y. NAKAGAWA, AND S. H. WENDER

Received July 13, 1959

No previous report has been made of the presence of caffeic acid (3,4-dihydroxycinnamic acid) in cigarette smoke. Several groups of workers[1-3] however, have reported finding free caffeic acid in various cured tobaccos, but Roberts and Wood,[4] using fresh cigar tobacco, and Weaving,[5] using flue-cured tobaccos, could find none in their samples. Dieterman *et al.*[6] have recently pointed out that esculetin (6,7-dihydroxycoumarin) in tobacco may often be confused on paper chromatograms with caffeic acid. In the present study on tobacco in eight brands of cigarettes commonly smoked in the U. S., every sample tested was found to contain free caffeic acid. Also, in every case, the main stream smoke from the cigarette contained free caffeic acid.

In the purification of scopoletin (6-methoxy, 7-hydroxycoumarin) from cigarette smoke and from various tobacco extracts,[7,8] two or more interfering blue fluorescing compounds persisted with the scopoletin through several developments of paper chromatograms. Dieterman *et al.*[6] identified one of these interfering compounds as esculetin. The present identification establishes free caffeic acid as the other blue fluorescing compound.

During paper chromatography in certain acid solvent systems, such as 15% acetic acid–water, caffeic acid appears as two distinct zones. These have been shown to be *cis-* and *trans-* caffeic acid.

EXPERIMENTAL

Caffeic acid from cigarette tobacco. The tobacco obtained from one hundred and twenty cigarettes (three each from forty packs of the same brand) was mixed and ground to a powder. Six 5.5-g. samples of this powder were thoroughly extracted with 85% isopropyl alcohol, as previously described by Yang *et al.*[7] The combined extracts were concentrated under reduced pressure, and the concentrate was then subjected to separation by mass paper chromatography.[7] After the initial chromatography with Whatman 3MM paper, using the solvent system *n*-butyl alcohol–acetic acid–water (6:1:2 v./v.), each zone containing caffeic acid, still mixed with some esculetin and scopoletin, was cut off and then eluted with methanol. The eluates were combined and streaked on S & S No. 589, Red Ribbon, chromatography paper, and developed in the system chloroform–acetic acid–water (2:1:1 v./v., bottom layer). This solvent system proved to be superior to the nitromethane-benzene-water system (2:3:5 v./v., upper layer) used in our previous studies on scopoletin and esculetin. In the chloroform system, the scopoletin (R_f = 0.75) moves in a narrow zone quite removed from those of esculetin (R_f = 0.39) and of caffeic acid (R_f = 0.35). This was also the case with the benzene–propionic acid–water system (2:2:1 v./v., top layer) with R_f values: scopoletin (0.66); caffeic acid (0.32); and esculetin (0.26). The two top zones resulting from paper chromatography with the chloroform system contained primarily caffeic acid and esculetin. They were cut off from each chromatogram together; sewn onto a new sheet of paper; and then developed in ethyl acetate–formic acid–water (10:2:3 v./v.). Each zone containing caffeic acid, with a trace of esculetin still present, was cut off and eluted with the ethyl acetate solvent system. The eluates were combined and again streaked on S & S No. 589 paper and developed in 15% acetic acid–water. Although separation of caffeic acid from esculetin was completed by this chromatography with acetic acid, an isomer of caffeic acid now appeared as a separate, third zone.

The two zones of isomeric caffeic acid were cut from each chromatogram as a unit and sewn onto a new sheet of chromatography paper. Each such sheet was then developed in the ethyl acetate system to obtain one narrow blue zone for identification studies.

Identification of caffeic acid. The combined eluates containing the purified caffeic acid from each single zone obtained in the ethyl acetate system were then co-chromatographed with authentic caffeic acid purchased from California Foundation for Biochemical Research, using the *n*-butyl alcohol–acetic acid–water, chloroform–acetic acid–water, ethyl acetate–formic acid–water, benzene–propionic acid–water, and nitromethane-benzene-water systems already described, and *n*-butyl alcohol–benzene–pyridine–water (5:1:3:3 v./v., upper layer), isopropyl alcohol–pyridine–acetic acid–water (8:8:1:2 v./v.), and 15% acetic

(1) F. Wilkinson, M. Phillips, and A. M. Bacot, *Jr. Assn. Off. Agric. Chemists*, **37**, 1004 (1954).
(2) M. Shiroya, T. Shiroya, and S. Hattori, *Physiol. Plant*, **8**, 594 (1955).
(3) M. K. Mikhailov, *Compt. Rend. Acad. Bulgare des Sci.*, **11**, 205 (1958).
(4) E. A. H. Roberts and D. J. Wood, *Arch. Biochem.*, **33**, 299 (1951).
(5) A. S. Weaving, *Tob. Sci.*, **2**, 1 (1958).
(6) L. J. Dieterman, C. H. Yang, Y. Nakagawa, and S. H. Wender, *J. Org. Chem.*, **24**, 1134 (1959).
(7) C. H. Yang, Y. Nakagawa, and S. H. Wender, *J. Org. Chem.*, **23**, 204 (1958).
(8) C. H. Yang, Y. Nakagawa, and S. H. Wender, *Anal. Chem.*, **30**, 2041 (1958).