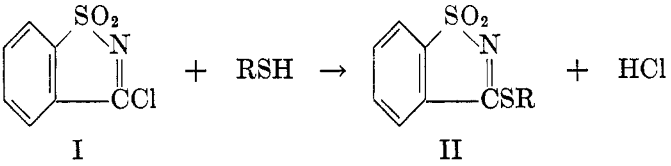
[Contribution from the Chemistry Department of the University of Kentucky]

USE OF SACCHARIN DERIVATIVES FOR THE IDENTIFICATION OF MERCAPTANS

J. R. MEADOW and J. C. CAVAGNOL[1]

Received November 27,1951

Previous work by Meadow and Reid (1) suggested the use of saccharin chloride (3-chlorobenzisosulfonazole) as a reagent for preparing derivatives of alcohols. The present authors have extended the use of this halosaccharin to the preparation of a series of crystalline derivatives of mercaptans having well-defined melting points suitable for identification purposes. Saccharin chloride (I), first reported by Jesurun (2) and later by Fritsch (3) and Schrader (4), behaves very much like an acid chloride in reactions with alcohols and mercaptans by evolving hydrogen chloride.



Using the sodium salts of methanethiol and ethanethiol with saccharin chloride (I), Meadow and Cavagnol (5) employed this type of reaction to establish the structures of the methyl and ethyl derivatives of thiosaccharin (II). This work suggested the preparation of other thio derivatives from this reagent as a means of identifying mercaptans or thiophenols.

Several methods of making derivatives of mercaptans have been reported. Hoffman and Reid (6) suggested the use of 1,5-butylanthraquinonesulfone sodium sulfonate with mercaptans to form alkyl thioether-anthraquinone-butyl-sulfones ($RSC_{14}H_6O_2$-$SO_2C_4H_9$) and the disulfones ($RSO_2C_{14}H_6O_2$-$SO_2C_4H_9$) by oxidizing the former with fuming nitric acid. Wertheim (7) reported mercaptan derivatives from 3,5-dinitrobenzoyl chloride and also from 3-nitrophthalic anhydride. Bost, Turner, and Norton (8) have prepared derivatives of mercaptans from 2,4-dinitrochlorobenzene; the resulting thioethers were then conveniently oxidized to higher-melting sulfones. Some lead and mercury mercaptides have also been prepared and listed as derivatives of a few mercaptans (7).

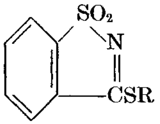
Saccharin chloride (1) was found to react smoothly and rapidly with a large number of mercaptans to produce the corresponding S-alkyl derivatives (3-alkylmercaptobenzisosulfonazoles) of thiosaccharin (II) and hydrogen chloride. These are colorless, crystalline compounds whose melting points and analyses are listed in Table I. The alkyl, aryl, or alkaryl groups in the first column represent the mercaptans used in each case.

---

[1] Present address: Lederle Laboratories Division, American Cyanamid Co., Pearl River, N. Y.

TABLE I

Thiosaccharin Derivatives (3-Alkylmercaptobenzisosulfonazoles)



R	M.P., °C[a]	FORMULA	ANALYSES					
			MW		N		S	
			Calc'd	Found	Calc'd	Found	Calc'd	Found
CH_3[b]	218–219	$C_8H_7NO_2S_2$						
C_2H_5[b]	183–184	$C_9H_9NO_2S_2$						
n-C_3H_7	102.5–103	$C_{10}H_{11}NO_2S_2$	241	235	5.80	5.70	26.57	26.52
i-C_3H_7[c]	177.5–178.5	$C_{10}H_{11}NO_2S_2$	241	232	5.80	5.78	26.57	26.94
n-C_4H_9	92–92.5	$C_{11}H_{13}NO_2S_2$	255	252	5.49	5.50	25.11	25.15
i-C_4H_9	96.5–97	$C_{11}H_{13}NO_2S_2$	51.74(C)	51.27(C)	5.13(H)	5.33(H)	25.11	25.09
tert-C_4H_9	122–124	$C_{11}H_{13}NO_2S_2$	51.74(C)	51.95(C)	5.13(H)	5.44(H)		
n-C_5H_{11}[d]	69–69.5	$C_{12}H_{15}NO_2S_2$	269	272	5.20	5.23	23.81	24.23
n-C_6H_{13}	46.5–47	$C_{13}H_{17}NO_2S_2$			4.94	4.92	22.63	23.19
n-C_7H_{15}	72–72.5	$C_{14}H_{19}NO_2S_2$			4.71	4.71	21.56	21.36
n-C_8H_{17}	45.5–46.5	$C_{15}H_{21}NO_2S_2$			4.50	4.50	20.59	20.42
n-C_9H_{19}	73–73.5	$C_{16}H_{23}NO_2S_2$			4.30	4.39	19.70	19.59
n-$C_{10}H_{21}$	59.5–60	$C_{17}H_{25}NO_2S_2$	60.14(C)	60.00(C)	7.42(H)	7.87(H)	18.89	18.59
n-$C_{11}H_{23}$	79.5–80	$C_{18}H_{27}NO_2S_2$			3.96	3.90	18.14	18.60
n-$C_{12}H_{25}$	67.5–68	$C_{19}H_{29}NO_2S_2$	367	358	3.81	3.97	17.45	17.47
C_6H_5	219.0–219.5	$C_{13}H_9NO_2S_2$	275	267	5.09	5.26	23.29	23.35
$C_6H_5CH_2$	137.5–138	$C_{14}H_{11}NO_2S_2$	58.11(C)	58.03(C)	3.83(H)	4.19(H)	22.16	21.96

[a] Uncorrected. [b] Ref. 5. [c] Calc'd: C, 49.77; H, 4.59. Found: C, 49.74; H, 4.57. [d] Calc'd: C, 53.50; H, 5.61. Found: C, 53.38; H, 5.90.

Figure 1 shows the variation in melting point with chain length for the *n*-alkyl series of mercaptan derivatives up to twelve carbon atoms. For comparative purposes, melting points of the corresponding alcohol derivatives of saccharin (1) are inserted in the same graph to show the similarity in pattern.

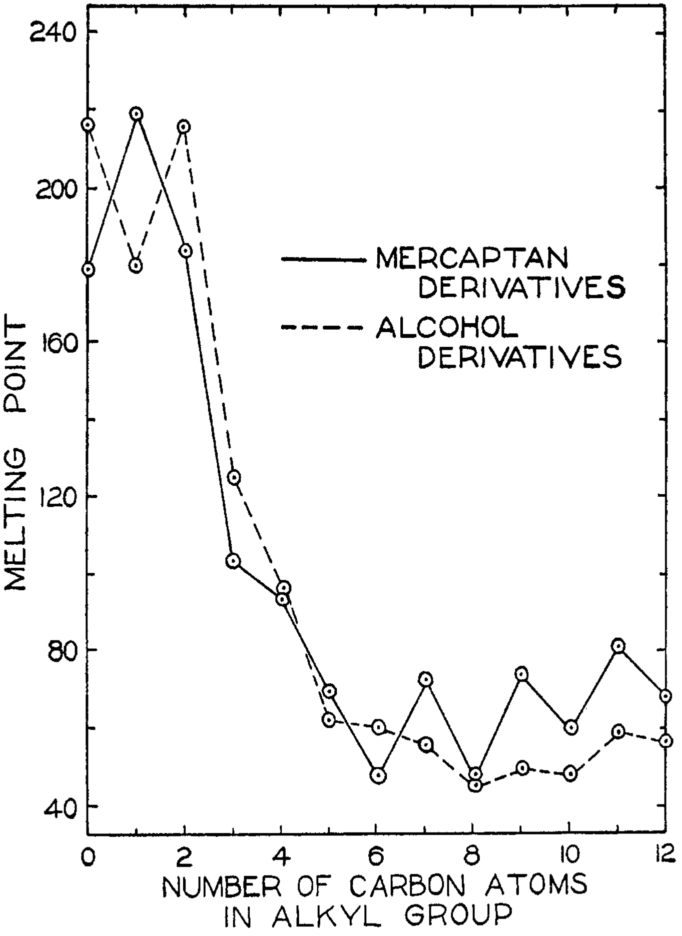


FIGURE 1. MELTING POINTS OF ALKYL SACCHARINS AND THIOSACCHARINS

EXPERIMENTAL

All mercaptans used in preparing these derivatives were purchased in highly purified form.

S-Alkylthiosaccharin derivatives. With the exception of methane-, ethane-, and 2-methyl-2-propane-thiol, the S-alkylthiosaccharins were prepared directly from the mercaptan and saccharin chloride by using a slight excess of the former with no solvent. The following preparation of the *n*-heptyl derivative is typical of the series: saccharin chloride (2.0 g., 0.01 mole) and *n*-heptanethiol mercaptan (1.6 g., 0.012 mole) were placed in a small open flask and warmed on a steam-bath for ten minutes, at which time the evolution of hydrogen chloride usually ceased. The product was taken up in 15 ml. of warm benzene, filtered hot, and sufficient petroleum ether (30–60°) was added to cause precipitation. The product was filtered and recrystallized from 95% ethanol yielding 70% of colorless crystals, m.p. 72–73°. Another recrystallization from ethanol sharpened the melting point to 72.5–73.0°.

Derivatives of the exceedingly volatile methane- and ethane-thiol, and the less reactive 2-methyl-2-propanethiol were more conveniently prepared by using a calculated quantity of the sodium thiol suspended in benzene, followed by addition of the saccharin chloride. The preparation of the S-methyl and S-ethyl derivatives by this method has been described in detail previously (5). The *tert*-butyl derivative was prepared in a similar manner. 2-Propanethiol, however, reacted more slowly than 1-propanethiol and other primary thiols.

Saccharin chloride (3-chlorobenzisosulfonazole). This reagent was prepared in the manner described by Meadow and Reid (1). For best results it was found that the crude reaction product from benzene, containing an appreciable amount of phosphorus chlorides, reacted rapidly with thiols. Further recrystallization from benzene-heptane produced white crystalline flakes, m.p. 145–147°. This product, however, reacted much more slowly with thiols than either the crude saccharin chloride or the purified product containing added phosphorus pentachloride.

Anal. Calc'd for $C_7H_4ClNO_2S$: C, 41.69; H, 2.00.
Found: C, 41.67; H, 2.07.

SUMMARY

A series of thiosaccharin derivatives possessing distinct melting points has been prepared and characterized for the purpose of identifying mercaptans. Fifteen new derivatives were made from saccharin chloride and the corresponding mercaptans with elimination of hydrogen chloride. The S-alkyl thiosaccharins of methane-, ethane-, and 2-methyl-2-propane-thiol were more conveniently prepared by using the sodium thiols.

LEXINGTON, KENTUCKY

REFERENCES

(1) MEADOW AND REID, *J. Am. Chem. Soc.*, **65**, 457 (1943).
(2) JESURUN, *Ber.*, **26**, 2287 (1893).
(3) FRITSCHE, *Ber.*, **29**, 2295 (1896).
(4) SCHRADER, *J. prak. Chem.*, (2) **95**, 314 (1917).
(5) MEADOW AND CAVAGNOL, *J. Org. Chem.*, **16**, 1582 (1951).
(6) HOFFMAN AND REID, *J. Am. Chem. Soc.*, **45**, 1837 (1923).
(7) WERTHEIM, *J Am. Chem. Soc.*, **51**, 3661 (1929).
(8) BOST, TURNER, AND NORTON, *J. Am. Chem. Soc.*, **54**, 1985 (1932).