

prepared from alkyl halides and sodium thiosulphate this alternative route is the more convenient. Thus *S*-(benzylthio)-L-cysteine was obtained in high yield by reaction of equimolar amounts of sodium *S*-benzyl thiosulphate and L-cysteine at pH 5-7. In this case the high yield can be attributed to the insolubility of the product in this pH range.

Experimental

Microanalyses were performed in the C.S.I.R.O. and University of Melbourne microanalytical laboratory. Paper chromatography was carried out using Whatman No. 1 paper and downward flow development with the following solvent systems: Solvent A, phenol: water (3:1), solvent B, butan-1-ol: acetic acid: water (4:1:1); solvent C, butan-2-ol: acetic acid: water (5:1:4). The amino acid spots were detected with ninhydrin.

(a) *L*-Cystine.—L-Cysteine hydrochloride monohydrate (1.05 g) was dissolved in 10 ml of a solution containing an equivalent amount of sodium *S*-sulpho-L-cysteinatate (Clarke 1932; for an improved procedure see Sorbo 1958), and acetic acid was added to bring the pH to 5. Nitrogen was bubbled through the solution, and after 18 hr, L-cystine (1.7 g) was filtered off and identified by colour reactions, paper chromatography, and optical rotation; $[\alpha]_D^{27} -208^\circ$ (*c.* 1.0 in 1N HCl).

(b) *s*-Benzylthio-L-cysteine.—(i) A solution of cysteine hydrochloride monohydrate (17.6 g) in water (100 ml) was added to a solution of sodium acetate trihydrate (40 g) in 2N NaOH (30 ml), the final pH being 6.5-7.0. Sodium *S*-benzyl thiosulphate (23 g) (Purgotti 1890) in water (75 ml) was added and after 2-3 hr the product was filtered off and washed well with water and finally with ethanol. The yield was 22 g (92%), m.p. 196 °C (decomp.); R_F in solvent A, 0.86; solvent B, 0.42; solvent C, 0.84. Chromatography revealed the presence of a trace of cystine (R_F 0.24 in solvent A, 0.12 in solvent B, 0.11 in solvent C).

The product was dissolved in 2N HCl (approx. 50 ml/g), the solution was filtered if necessary and the pH adjusted to *c.* 3 with NaOH or NaOAc. The unsymmetrical disulphide was thereby recovered in almost quantitative yield and was free of contaminating cystine (Found: C, 49.7; H, 5.6; O, 13.5%. Calc. for $C_{10}H_{13}NO_2S_2$: C, 49.4; H, 5.4; O, 13.2%), $[\alpha]_D^{20} -108.3^\circ$ (*c.* 0.57 in 2N HCl). The yield was maximal (*c.* 90%) over the pH range 5.5 to 7.5 and decreased markedly to 21% at pH 3.5 with a significant increase in cystine content. Bretschneider and Klötzer (1950) have prepared *S*-benzylthio-L-cysteine hydrochloride by an alternative method.

The amino acid was recovered unchanged after being heated under reflux in N HCl for 3 hr or after being kept for 2 hr in 15% NH_4OH at room temperature. A solution in N NaOH (0.5 g in 10 ml) rapidly deposited dibenzyl disulphide (0.24 g, m.p. 71 °C) while acidification of the filtrate to pH 4 yielded cystine (0.22 g). These products were also isolated when the amino acid was heated under reflux in 6N HCl for 2 hr or when it was warmed to 50 °C in a saturated solution of HBr in acetic acid. A quantitative yield of dibenzyl disulphide was also formed when the amino acid was shaken in a solution of sodium sulphite for 24 hr.

(ii) To a solution of sodium *S*-sulphocysteinatate (0.02 mole) and strontium chloride (0.02 mole) at pH 8 was added toluene- ω -thiol (0.02 mole). The heavy precipitate which formed immediately was filtered off after 30 min, digested with N HCl (20 ml) to remove strontium sulphite, and the insoluble amino acid filtered off and washed with water and ethanol. Yield 2.5 g (52%), m.p. 193-194 °C (decomp.). The compound was chromatographically identical with that obtained in (i) above.

(c) *Mono-N*-benzyloxycarbonyl-L-cystine.—(i) *NN'*-Bisbenzyloxycarbonyl-L-cystine (4 g) was dissolved in 0.1N $KHCO_3$ (170 ml) containing sodium sulphite heptahydrate (6 g) and a trace of ferric chloride. Air was passed through the solution until the nitroprusside test was negative (*c.* 24 hr), the pH was adjusted to 4, and air was again passed to remove SO_2 . To this solution, presumably containing *N*-benzyloxycarbonyl-*S*-sulpho-L-cysteine, was added L-cysteine hydrochloride (2.5 g) and sufficient alkali to maintain the pH at 4. Nitrogen was passed through the solution for 24 hr after which time *mono-N*-benzyloxycarbonyl-L-cystine, 1.6 g (54%), m.p. 190 °C, separated. Swan (1956) reports m.p. 193-194 °C (see also Marshall *et al.* 1957). The

product was chromatographically identical with an authentic specimen, R_F in solvent A, 0.60, in solvent B, 0.27. Chromatography following treatment on the paper with sodium sulphite showed the presence of a new intense spot due to *S*-sulphocysteine, R_F 0.06 in solvent A.

(ii) *N*-Benzyloxycarbonyl-L-cysteine (5.1 g), prepared from *NN'*-bisbenzyloxycarbonyl-L-cysteine by reduction with Zn in HCl, was added to a solution containing equivalent amounts of *S*-sulpho-L-cysteine and strontium chloride at pH 9. The precipitate of strontium sulphite was removed, and the pH of the filtrate was adjusted to 4, when mono-*N*-benzyloxycarbonyl-L-cysteine separated. Yield 3.7 g (50%), m.p. 193 °C (decomp.).

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CORRIGENDUM

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Page 252, line 5: For (1 mole) read (half the theoretical quantity).