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Studies on the Synthesis of Protein Analogus (Part VI)
Polymerisation of L-leucine, Co-polymerisation of L-leucine
and DL-phenylalanine, and Co-polymerisation
of Glycine and DL-alanine.

By

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By using the Noguchi's method¹⁾ by which N-carbothiophenyl-amino acids can be polymerized in polypeptide, poly-L-leucine, copoly L-leucine and DL-phenylalanine, and copoly glycine and DL-alanine, each with high polymerisation degree, were prepared.

The N-carbothiophenyl-L-leucine (syrup) and N-carbothiophenyl-DL-phenylalanine (m. p. 56 °C) which were employed in polymerisations were prepared as described in the Part I.²⁾

In these polymerisations, the solution polymerisation also gave better results than the block polymerisation. Benzene was used as solvent in the polymerisation of L-leucine and in the co-polymerisation of L-leucine and DL-phenylalanine, and dioxane was used in the copolymerisation of glycine and DL-alanine. Adding a small quantity of pyridine to the solutions, the polymerisation reaction were accelerated. In poly-L-leucine, the monomer, which was dissolved in benzene or in benzene containing ten moles pyridine to the sample, was heated at 80 °C for long hours in a sealed tube. The viscosity of solution increased with the progress of polymerisation, and protein-like polymer precipitated in swollen clear gel. Now and again, it was agitated to become uniform. The gel polymer was precipitated from the solvent with the progress of polymerisation.

It was insoluble in water, alcohol, benzene and acetic acid, and soluble in dichloroacetic acid. Biuret's reaction was not observed. The analysis corresponded to poly-L-leucine.

The molecular weight and the polymerisation degree were measured by osmotic method in dichloroacetic acid solution and the viscosity was determined with Ostwald's viscosimeter.

molecular weight $M=26,689$, polymerisation degree $n=236$, intrinsic viscosity $[\eta]=0.312$

In the copolymerisation of L-leucine and DL-phenylalanine, N-carbothiophenyl-L-

* It was published in the Jan. of the Chem. Soc. of Japan **75**, 645—647 (1954) (in Japanese).

1) J. Noguchi, *ibid.* **74**, 963 (1953) ; *ibid.* **75**, 639—645 (1954) (in Japanese).

2) J. Noguchi, K. Miyamori, S. Ishino, Jan. of the Chem. Soc. of Japan **75**, 641 (1954)

was somewhat viscous. It was clearer and in more soluble state than in pure benzene solvent (A). It was precipitated with a large amount of alcohol, centrifuged, washed with ether and petrol ether, and dried. White powder. Yield 49 mg. (29% of the theoretical).

The molecular weight and the viscosity were measured with the sample (A).

Molecular weight : It was measured at 30 °C by the Meshizuka's osmotic method⁴⁾ in dichlor-acetic acid

Concentration $C=4.78$ g/L, Osmotic press. $\pi=4.45 \times 10^{-3}$ atm.

Molecular weight $M=26,689$, polymerisation degree $n=236$

Viscosity : It was measured at 30 °C in dichlor-acetic acid.

intrinsic viscosity $[\eta]=[\eta_{sp}/c]_{c \rightarrow 0}=0.312$

Copoly-(L-leucine and DL-phenylalanine)—N-carbothiophenyl-L-leucine 0.67 g and N-carbothiophenyl-DL-phenylalanine 0.75 g was dissolved in benzene 40 cc and kept at 60 °C for 1000 hours. The viscosity increased with the progress of polymerisation. It was precipitated with ligroin, centrifuged, washed with ether several times and dried. Yield 0.3 g (44.3% of the theoretical)

N analysis found N=10.49%

for $(C_9H_9NO:C_6H_{11}NO=1:1)_n$ calc. N=10.76%

Molecular weight : Sample of about 40 mg was refluxed with benzene 12 cc for several hours, dissolved completely, and left overnight. The concentration was determined after evaporating the solution to dryness.

Concentration $C=3.30$ g/L, Osmotic press. $\pi=5.09 \times 10^{-4}$ atm.

Molecular weight $M=161,000$

Viscosity : It was measured at 30 ± 0.1 °C with Ostwald's viscosimeter.

intrinsic viscosity $[\eta]=[\eta_{sp}/c]_{c \rightarrow 0}=2.42$

Copoly-(glycine and DL-alanine)—N-carbothiophenyl-glycine 2.11 g and N-carbothiophenyl-DL-alanine 2.25 g was dissolved in hot dioxane 50 cc containing pyridine 7.9 g and polymerized at 60 °C for 1000 hours. Protein-like polymer separated out in opaque gel. It was centrifuged, separated from the mother liquor, refluxed with absolute alcohol for scores of ten minutes, centrifuged, washed with ether and dried. Further, it was dried at 150 °C in vacuum for 3 hours. It was white powder and a little hygroscopic. Yield 0.46 g (35.93% of the theoretical).

N analysis found N=20.60%

for $(C_2H_3ON:C_3H_5ON=1:1)_n$ calc. N=21.88%

It was dissolved in water and the molecular weight and the viscosity were measured at 30 ± 0.1 °C.

Concentration $C=3.38$ g/L, Osmotic press. $\pi=7.33 \times 10^{-3}$ atm.

Molecular weight $M=11,457$, polymerisation degree $n=89.5$, intrinsic viscosity $[\eta]=0.093$

4) G. Meshizuka, The Chemistry of Highpolymer 6, 305 (1949).