

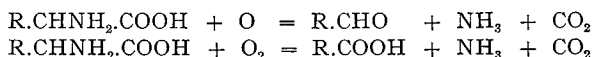
NOTE ON THE OXIDATION OF GLUTAMIC AND ASPARTIC ACIDS BY MEANS OF HYDROGEN PEROXIDE.

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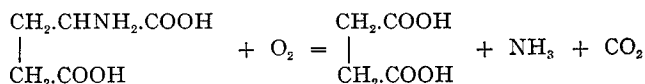
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In previous communications¹ it has been shown that a number of amino-acids of the typical formula R.CH.NH₂.COOH, undergo oxidation with hydrogen peroxide so as to yield ammonia, carbon dioxide and an aldehyde R.CHO, the latter being more or less oxidized to the corresponding acid, according to the conditions of the experiment:



This reaction was found to occur in the case of glycocoll, alanin, α -amidovaleric acid, α -amido-isovaleric acid, leucin and phenylalanin, and was of especial interest on account of the similarity of the products of oxidation with those obtained through some biochemical oxidative changes.

The following experiments were undertaken in order to ascertain whether the reaction could be extended to the dibasic amino-acids. This was found to be the case. Glutamic acid proved to be readily oxidized when the ammonium salt was gently warmed with hydrogen peroxide, with liberation of ammonia and carbon dioxide and formation of large quantities of succinic acid. The reaction may be expressed as follows:



¹ This *Journal*, i, pp. 171 and 271; iv, p. 63.

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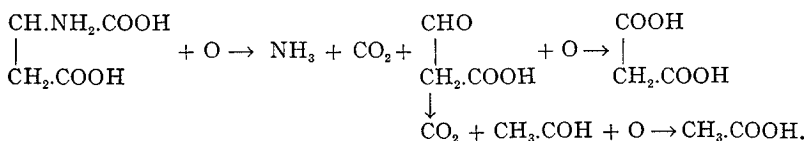
The reaction is clearly analogous to the oxidation of the mono-amino-acids under similar conditions. Aldehyde-butyric acid,¹ $\text{COH}\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{COOH}$, may be considered as an intermediary product, but no indications of the presence of this substance were obtained.

The formation of succinic acid from glutamic acid through oxidation with hydrogen peroxide is of interest since a precisely similar reaction is brought about by the action of yeast (Ehrlich) and also through the agency of putrefactive organisms.²

The oxidation of aspartic acid with hydrogen peroxide showed that essentially the same reaction took place. The change is complicated, however, by the fact that the primary product of the reaction, namely the half aldehyde of malonic acid is very unstable and breaks up with extreme ease into acetaldehyde and carbon dioxide, both of which products were readily identified. A small amount of malonic acid was isolated, however, it doubtless being formed from the further oxidation of the aldehyde acid.

In addition, minute quantities of acetic acid and formic acid resulting from the further oxidation of the acetaldehyde were identified.

The changes may be represented as follows:



EXPERIMENTAL.

Oxidation of glutamic acid. One-tenth gram mol. of glutamic acid was neutralized by the addition of a slight excess of ammonia and then gently warmed to about 70° with 0.3 gram mol. of 2.5 per cent hydrogen peroxide. After about an hour the liquid was distilled. The residue did not reduce Fehling's solution, aldehyde-butyric acid was therefore absent. It was acidified with phosphoric acid and extracted with ether in a continuous

¹ Perkin and Sprankling: *Trans. Chem. Soc.*, lxxv, p. 16.

² W. Brasch and C. Neuberg: *Biochem. Zeitschr.*, xiii, p. 299.

extraction apparatus. On distilling off the ether a crystalline residue of succinic acid was obtained amounting to 47 per cent of the theoretical amount. It was recrystallized from water and melted at 180–181°. A considerable amount of unoxidized glutamic acid was present in the solution after extraction with ether, so that by repeating the oxidation it would be possible to still further improve the yield of succinic acid.

Oxidation of aspartic acid. Sodium aspartate, 0.1 gram mol., was oxidized with 0.3 gram mol. of neutral hydrogen peroxide. A trace of ferrous sulphate was added as a catalyst. After standing for a few minutes at the ordinary temperature of the room, the liquid became warm and a vigorous reaction took place with evolution of much carbon dioxide. The liquid was acidified and distilled. The distillate contained acetic and formic acids equivalent to approximately 0.25 gram of acetic acid. In addition all the usual reactions for acetaldehyde were obtained including Rimini's reaction with sodium nitroprusside and piperidine. The distillate was redistilled and the first portion to come over was treated with para-nitrophenylhydrazine acetate in the usual way. The small amount of precipitated hydrazone was recrystallized from alcohol and melted at 127–128°. The para-nitrophenylhydrazone of acetaldehyde melts at 128–128.5°.

The residue from the first distillation was acidified with phosphoric acid and extracted with ether. On evaporation of the ether a crystalline residue of malonic acid was obtained. It was identified by its melting point (131–132°) and by its rapid decomposition with liberation of carbon dioxide at the same temperature. The yield of malonic acid was considerably less than the corresponding yield of succinic acid from the oxidation of glutamic acid.