Free Amino Acids in Brewing Materials

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The free amino acids occurring in a sixrow barley (Stella) and in malt, wort and beer prepared from this barley have been quantitatively determined by means of chromatography on Dowex 50 [1].

The amino acids were determined in water extracts of barley and malt samples previously boiled in alcohol to inactivate the proteolytic enzymes. Barley contains very small amounts of free amino acids. Alanine, aspartic acid, asparagine and glutamic acid occur, however, in quite considerable quantities. Proline and γ-aminobutyric acid are also present in rather large amounts. During the malting there was a general increase of the free amino acids, but most remarkable was the increase of free proline.

The samples of wort, hopped wort, beer and beer refermented after addition of glucose, were treated with alcohol to precipitate proteins and carbohydrates before the determinations of the amino acids. During the mashing process there was a general increase of the free amino acids, which indicates that a considerable peptidase action occurred during the mashing. Arginine, leucine, lysine, phenylalanine and valine showed the greatest increase. When the wort was boiled with hops, there was an increase of some of the amino acids, particularly of aspartic acid, threonine and valine. There was a remarkable decrease, however, of arginine, histidine, lysine, glutamic acid and also of tyrosine during the boiling. A possible explanation for this decrease is that the boiling involves a reaction of amino acids and carbohydrates, with the formation of melanoidines. The fermentations were performed with bottom yeast *(Saccharomyces Carlsbergensis)*. During the first fermentation all of the amino acids decreased except γ-aminobutyric acid which increased. During the refermentation all amino acids decreased, but proline, γ-aminobutyric acid, glycine and alanine only to a rather small extent. In the chromatograms at least 10 unknown substances could be demonstrated, several of which are probably peptides. The results obtained in the fermentation experiments generally agree well with those of Barton-Wright [2] obtained with microbiological methods for the determination of the amino acids. The excretion of glutamic acid and the assimilation of glycine by the yeast found by Barton-Wright, however, could not be demonstrated in our experiments.

1. Moore, S. and Stein, W. H. *J. Biol. Chem.* **192** (1951) 663.
2. Barton-Wright, E. C. *European Brewery Convention* **1949** 19.

The Incorporation Rate of Phosphorus into Phosphoproteins from Different Organs

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Earlier reported work [1] has been continued and the incorporation rate of phosphorus into phosphoproteins of rat brain, heart, intestinal mucosa, kidney, liver and spleen has been determined. The previously described procedure [1] has been followed which means that the specific activities have been determined in the phosphoserine and phosphopeptide fractions isolated on a Dowex 50 column after acid hydrolysis of the Schneider protein residues obtained from the different organs. In Table 1 the rate of P^{32}-incorporation in the liver phosphoserine fraction is illustrated.

Table 1. Specific activity of the phosphoserine fraction from rat liver at different times after the injection of 1 μC P^{32} per g body weight.

Time in hours	Specific activity in *cpm* per μg P
0.5	107
1	836
2	929
6	827
24	102
30	84

The highest value for the specific activity seems to be obtained in the liver. The phosphoserine and phosphopeptide fractions obtained from Dowex 50 columns are not homogeneous. Gradient elution from Dowex 1 in formate form [2] has enabled us to separate each of these fractions into several subfractions. Phosphoserine dominates the phosphoserine fraction, but otherwise each phosphopeptide from Dowex 50 seems to consist of several peptides with different amino acid composi-