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Czech J. Food Sci.

Novotný O., Cejpek K., Velí šek J.:

Formation of carboxylic acids during degradation of monosaccharides

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The formation of low molecular carboxylic and hydroxycarboxylic acids as well as sugar and deoxysugar acids from monosaccharides (D-glucose, D-fructose, D-arabinose, DL-glyceraldehyde, and 1,3-dihydroxyacetone) was studied in three different model systems: aqueous and alkaline solutions of potassium peroxodisulfate ($K_2S_2O_8$), and sodium hydroxide solution. In total, 3 low molecular carboxylic acids (formic, acetic and propionic), 24 hydroxycarboxylic acids, and 12 corresponding lactones were identified and quantified by GC/MS. Formic, acetic, and propionic acids were isolated by extraction with diethyl ether and directly analysed by GC/MS; hydroxycarboxylic acids and their lactones were monitored as their trimethylsilylated derivatives using the same method. Formic, acetic, L-lactic,

glycolic, DL-2,4-dihydroxybutanoic acids and aldonic acids derived from the parent sugars were the most abundant compounds in all model systems. Within the models investigated, the yield of carboxylic acids and hydroxycarboxylic acids (together with their lactones) ranged between 9.3 – 22.2% (n/n) and between 3.6 – 116.9% (n/n), respectively. The amount of acids was significantly lower in aqueous solutions of $K_2S_2O_8$ than in the alkaline solutions. The data obtained indicate that lower carboxylic acids are formed by both subsequent reactions (oxidation and/or intramolecular Cannizzaro reaction) of the sugar fragmentation products and direct decomposition of some intermediates such as uloses or hydroperoxides derived from the parent sugars. The acids possessing the original sugar skeleton are formed as a result of sugar oxidation or benzilic acid type rearrangement of deoxyuloses. Lower acids may also be formed by a recombination of free radicals.

Keywords:
carboxylic acids; hydroxycarboxylic acids; lactones; oxidation; Cannizzaro reaction;

benzilic acid type rearrangement; peroxodisulfate

[fulltext]