Elucidation of the Relationship between the Chemical Structures of Saccharides and Caramelization

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Saccharides, a widely used major energy source for humans, turn brown when exposed to high temperatures, such as during cooking. The brown color is in part due to caramelization, a reaction that occurs only with sugars through an incompletely understood reaction pathway. Previous studies revealed that heating an aqueous sucrose solution produces fructose and glucose, then fructose is converted into 5-hydroxymethylfurfural (HMF). Heated disaccharide crystals have been previously shown to decompose to monosaccharides. The aim of the present study was to elucidate the relationship between the chemical structures of polyols and caramelization. I used ten polyols that can be categorized as aldoses, including glucose, galactose, mannose, ribose, deoxyribose and deoxyglucose, the ketoses fructose and sorbose, and the sugar alcohols sorbitol and xylitol. Polyol crystals were heated on an electric griddle at 260°C or in an oven at 180°C for different periods of time and observed for color changes. I found that ketoses browned faster than aldoses and that sugar alcohols did not change color. The caramels were analyzed by thin layer chromatography, dynamic light scattering and spectroscopic methods. The results indicated that fructose, sorbose, mannose, galactose and glucose formed HMF. In addition, ketoses produced more HMF and larger particles derived from HMF than aldoses. I concluded that caramelization occurs if the sugar structure contains a formyl group at the 1-position, or a hydroxy group at the 1-position and a ketone group at the 2-position. These findings may improve nutrition and lead to more efficient means of utilizing waste carbohydrates as new energy sources.

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