Chemistry update
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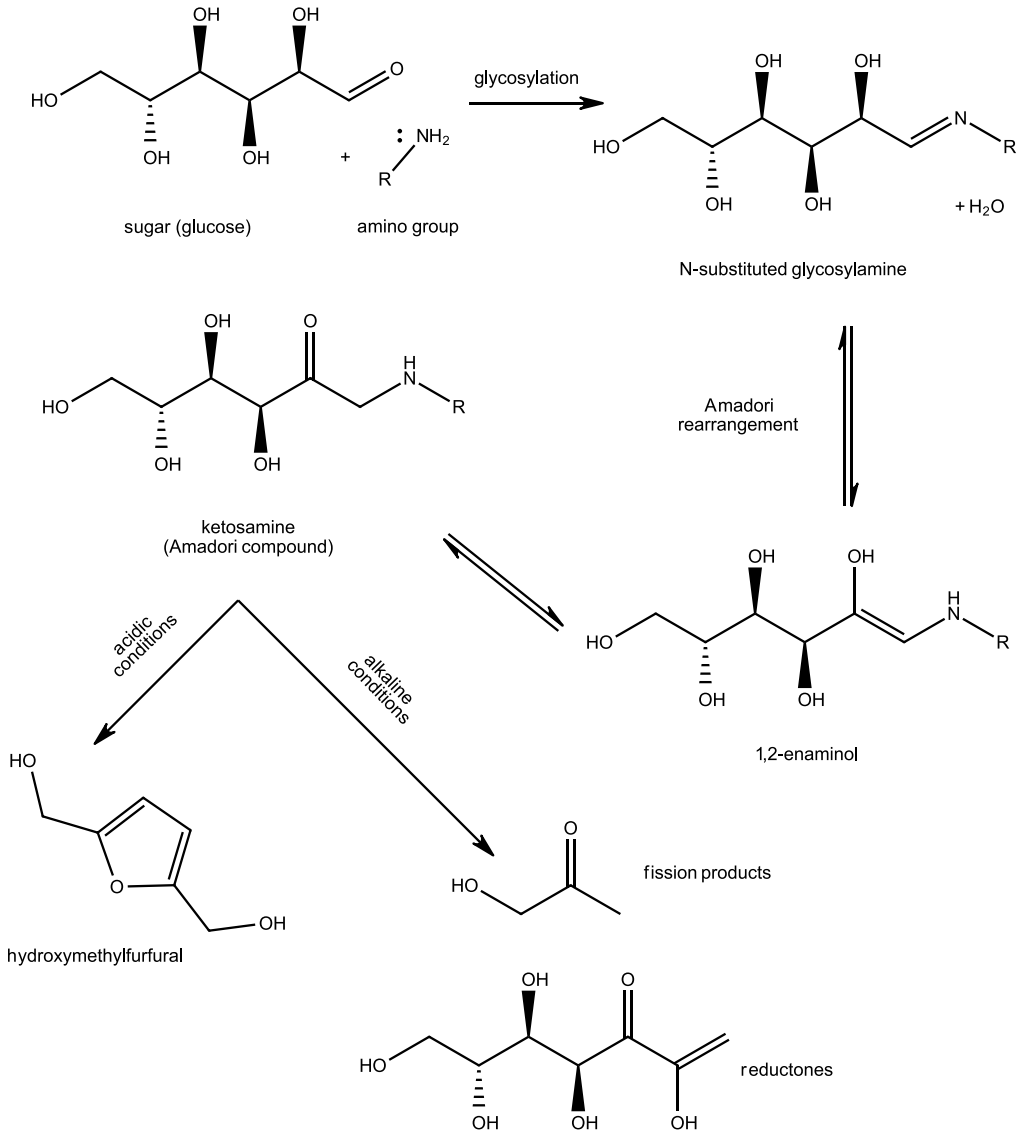
Perfect potatoes

Whether it be latkes or roasties, chemistry is the secret to tasty taters this festive season. **Joseph Lloyd** explains

Figure 1 Maillard reaction



Food is a big part of many festivities, and Hanukkah and Christmas are no exception. Despite all the food on offer, it is often the humble potato that is held closest to our hearts. It was Queen Victoria who introduced mashed potatoes to British Christmas celebrations, with roasties rapidly ascending to popularity later on.

The latke, a type of pancake, has been associated with Hanukkah for centuries. They can be based on a range of ingredients, but the potato latke has its origins in nineteenth-century Eastern Europe. Despite the many differences between roast potatoes and potato latkes, there is at least one point of accord: they are better when they are golden brown and crispy.

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Maillard's miracle

It is the Maillard reaction that is responsible for the non-enzymatic browning of many of our favourite festive foods (Chemistry Review Vol. 11, No. 2, pp. 30–33). It occurs between amino acids and reducing sugars at between 130°C and 180°C and follows a three-step process (Figure 1).

Glycosylation

The first reaction is a condensation reaction between an amine group from a protein or amino acid and a carbonyl group on the sugar. An imine bond results, producing a compound known as an N-substituted glycosylamine, plus a molecule of water as a leaving group.

Amadori rearrangement

Next comes the Amadori rearrangement, an isomerisation reaction that sees one molecule transform into another molecule with the same molecular formula but a different structure. In this case, there are three compounds involved: glycosylamine (from the previous step), 1,2-enaminol and an Amadori compound. The reactions between the glycosylamine and 1,2-enaminol, as well as between 1,2-enaminol and the Amadori compound, are both reversible. The Amadori compound is a ketosamine, which goes on to react in the third stage.

It depends

What happens next all depends on the reaction context, such as whether the reaction is occurring in acidic or alkaline conditions. This means there can be a range of outcomes, but the most important one for the perfectly coloured potato are melanoidins. These are a class of polymer that ultimately give roasties or latkes their ideal, golden-brown colour.

We know relatively little else about melanoidins because of the huge numbers of Maillard reaction products that can occur. It is therefore difficult to identify and isolate individual compounds. Included within the range of possible outcomes are also an array of aromatic compounds, such as pyrazines, pyrroles, furans and furanones. It is these that are responsible for those irresistible flavours.

Not just for the festive season

Of course, sugars and amino acids are present throughout our foods, so Maillard's reaction is responsible for many of our other favourite foods and flavours. From the baking of bread to the searing of meat and roasting of coffee beans (Chemistry Review Vol. 32, No. 2, pp. 8–12), all employ the Maillard reaction to impart some of the flavours we adore throughout the year. Enjoy a golden festive season.

Question

1 Outline the mechanism of the condensation reaction that forms the glycosylamine.

Answer

1
- The lone pair from the nitrogen of the amine group attacks the electrophilic carbon of the carbonyl group.
- Electrons are pushed away from the double bond and towards the oxygen atom, giving it a negative charge.
- A proton is then transferred from the positively charged nitrogen to the negatively charged oxygen atom.
- The oxygen atom donates its lone pair to a proton, creating OH_2^+.
- Nitrogen donates its lone pair to form a new carbon–nitrogen bond. At the same time, H_2O is created as a leaving group.