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Burnt Caramel: From the Flavour Wheel to the tasting room

Dr Javier Gomez-Lopez, Dr Boris Gadzov and Dr Ronald Nixdorf (FlavorActiV Ltd)

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Introduction

The craft brewing revolution has sparked considerable interest in beer styles with more complex flavour profiles. Brewers nowadays are using more specialty malts and adjuncts to achieve a wide range of flavours, ranging from malty biscuit to strong burnt caramel. These flavours, not generally found in mass produced beers, present a challenge to the beer tasters both in terms of flavour identification as well as flavour intensity evaluation.

Traditionally, sensory training of these flavours has been done by direct evaluation of wort samples prepared from specialty malts, or by dissolving heated sugars up to the caramelisation point in water. These processes are difficult to control and the results might vary both in chemical composition and also in sensory perception. Therefore, a burnt caramel flavour standard was required.

In nature, pyrazines are formed by the Maillard Reaction between reducing sugars and amino-acids. The reaction is a form of nonenzymatic browning which typically proceeds rapidly from around 140 to 165 °C. At higher temperatures, caramelisation and subsequently pyrolysis products are produced, among them, the pyrazines responsible for the burnt caramel flavour.

Sources of caramel flavours

The Maillard Reaction creates a substantial number of pyrazines, each with a different sensory profile, and each flavour is dependent upon the starting product during this reaction.

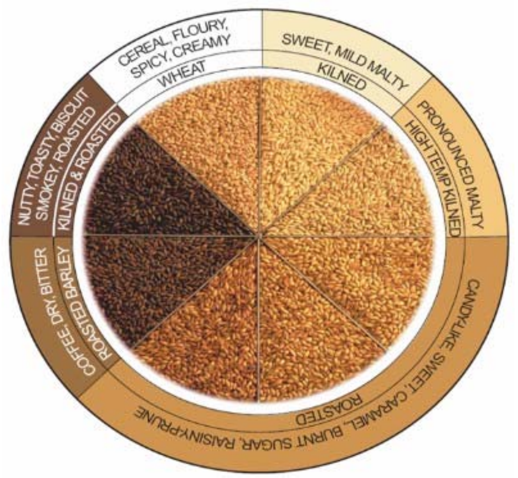
Caramel flavours can also be caused by the caramelisation of sugars – from heating rather than from an amino acid interaction as found in the Maillard Reaction.

This can produce flavours other than pyrizines such as furanones.

To understand the specific flavour that we wanted to target, FlavorActiV reviewed the processes of why burnt caramel flavours occur in beer.

Burnt caramel occurrence in beer

There are two possible methods to add caramel flavour to beer; one is to select a caramel malt (such as Caramel 60 °L, 80 °L, 90 °L, and 120 °L) and the other is to boil the wort for a long period (over 2 hours). This maximises the flavour by encouraging the caramelisation reactions.



Flavour standard selection

The Maillard Reaction produces a complex mixture of products which can be difficult to characterise and reproduce. In order to overcome this difficulty FlavorActiV took the project to develop a GMP Flavour Standard that mimics the sensory attributes of burnt sugar in beer.

There were several other criteria that guided the flavour selection process:

1) Sensory perception

The flavour easily needs distinguishable by odour and taste. This is required to assist in sensory training.

2) Safety

Most flavours are safe in the correct concentrations, however ensuring that they are selected from reputable suppliers and free of any impurities requires significant research.

3) Flavour concentration

A flavour may be suitable for use however the amount of material required to reach a sensory threshold may be significant. The lower the amount needed for sensory detection the better.

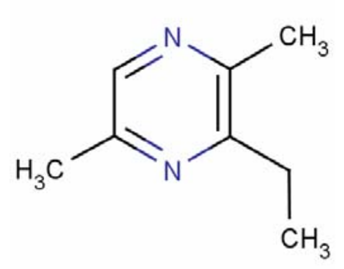
4) Ability to complex with cyclodextrins

To render a flavour suitable for use as a flavour standard it requires complexation with cyclodextrins. Some flavours due to their molecular structure are not suitable for this.

Final flavour selection

After considering several candidates, such as caramel furanones and coffe furanones via literature and research review and sensory and chemical testing, the following compound was selected:

3-ethyl-2,5 dimethylpyrazine



This flavour has a burnt sugar- / caramel-like flavour and odour and is commonly produced as part of the Maillard Reaction in many food types. It is also found in grains due to malting and kilning.

Sensory evaluation indicated that the concentration of this flavour was suitable for sensory training.

Chemical structure for complexation

The chemical structure of the flavour is suitable for complexation – although there are two polar groups their charge is regulated by the ring structure. All the other groups are non-polar and would indicate a good complexation during production.

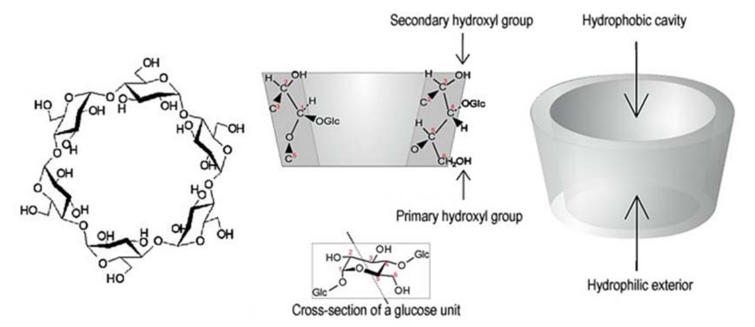
Next steps

The flavour is required to be stabilised and trialled to ensure that it is released correctly into beer. This is conducted using trial batches of complexed flavour being sensory reviewed against raw flavour material via a trained sensory panel.

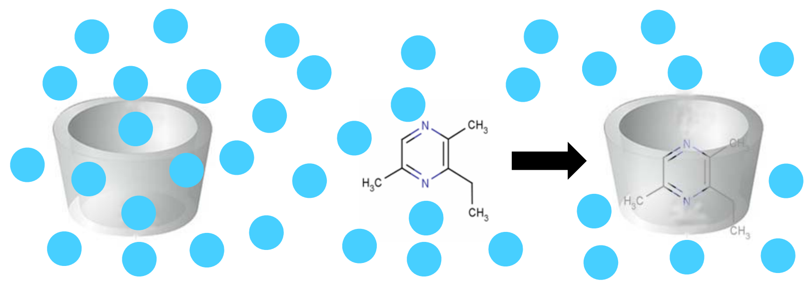
Molecular encapsulation

Once the flavour standard was selected, it was molecularly encapsulated in a suitable cyclodextrin. Cyclodextrins are cyclic oligosaccarids with a hydrophobic interior cavity and a hydrophilic exterior. Cyclodexrtrins have the following desirable effects on the encapsulated molecules:

- Lower vapour pressure preventing evaporation
- Protect oxidation-sensitive guest molecules from degradation by atmospheric oxygen
- Delay photo-oxidative degradation and breakdown
- Increase the water solubility and senso-avalibility.



Structure of α-Cyclodextrin



Conclusions

A pyrazine representative of the Maillard Reaction that gives the burnt caramel character to beer was selected among several candidates and molecularly encapsulated in cyclodextrin to produce GMP Caramel Flavour Standard.