Vitana Food Ingredients

Process flavourings and food quality

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Summary

The production of process flavourings is based on the utilization of products of non-enzymatic browning reactions, which most importantly include reactions of reducing sugars with amino acids, peptides and proteins (Maillard reactions). These reactions are accompanied by many other reactions, e.g. caramelisation, other reactions of the sugars resulting in the occurrence of acid and hererocyclical products, reactions of proteins, peptides and amino acids with oxidised lipids etc.

All types of meat, including poultry, but also yeast, plant extracts and extracts from sea animals are used as sources of proteins. The most widely used sugars include dextrose and pure glucose, less often xylose. Production also utilizes vegetable and animal fats. Reactions occur under strictly controlled conditions at higher temperatures and free oxygen access in a dark environment. It is possible to obtain a very wide range of different flavourings by using different input materials and different controlled reaction conditions.

Many aromatic compounds of different structures are created during the reaction depending on the reaction conditions and the input material. The most important flavouring components include aliphatic aldehydes (which can subsequently react with amino acids and proteins), nitrous, oxygenous, sulphurous and mixed heterocycles. Some other compounds contribute to the resulting aroma – sugar degradation products (e.g. glyoxal), reductones, premelanoidins and others. These substances are often highly reactive intermediate products. The choice of input materials and reaction conditions makes it possible to obtain different aroma profiles, e.g. the aroma of various types of roasted meat, fried, caramel or piquant aroma etc.

Process flavourings are products of a purely natural origin. They constitute the most important input material for the preparation of different flavouring substances, aromatic mixtures and seasoning products used in foodstuffs that can have a large effect on the sensorial quality of the final meal. They are also used as the fundamental aroma for the preparation of bouillons, instant soups, gravies and sauces, which are currently highly preferred by consumers.

Introduction

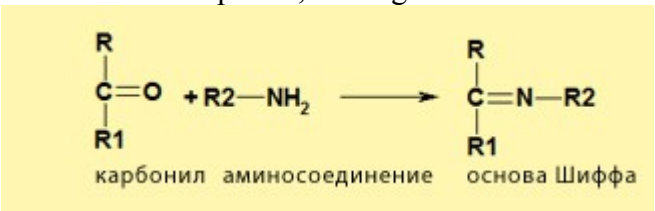
The EU Flavours Directive 88/388/EEC defines process flavourings as follows:

“A product of heating together a mixture of ingredients, not necessarily themselves having flavouring properties, of which at least one contains amino nitrogen and another is a reducing sugar, to a temperature not exceeding 180°C for a period not exceeding 15 minutes”.

The production is based on the use of products of non-enzymatic browning reactions, which particularly include the reactions of free reducing sugars with amino acids, but also with peptides or proteins (Maillard reaction). However, many other reactions also contribute – caramelisation, other sugar reactions leading to the creation of acid or heterocyclic products, reactions of proteins as well as amino acids with oxidized lipids and so on. If the temperature is lower than the specified value, the heating time can be adjusted as needed.

Reaction mechanisms and products

Non-enzymatic browning reactions are based on the reaction of a free carbonyl group in substances with the structure of aldehydes or ketones (aldehydes are far more reactive) with a free amino group of an amino compound, leading to the creation of the so-called Schiff base:



Rys. 1. Creation of the Schiff base

Schiff bases are unstable compounds that are spontaneously converted into similarly unstable glycosylamines, which enter the subsequent non-enzymatic browning reactions – rearrangements, condensations and other reactions. The following figure shows the most typical of all glycosylamines – glucosylamine derived from glucose.

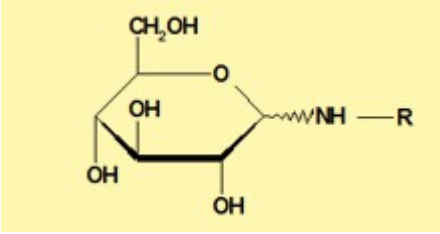


Fig. 2. Glucosylamine structure

The most important sugar in the group of monosaccharides that contributes to the Maillard reaction in foodstuffs is glucose; the most important disaccharides are lactose (in milk and milk products) and maltose (in cereal products, e.g. malt). Sugars bound by a glycosidic linkage in glycoproteins, glycolipids and heteroglycosides, but also non-reducing sugars (e.g. saccharose) can participate in the Maillard reaction after hydrolysis to monosaccharides.

The reaction partners of reducing sugars are mostly proteins and free amino acids. Proteins react with reducing sugars mostly through the ending ε-amino group of the bound lysine. To a small extent the reaction also involves α-amino groups of N-ending amino acids and other functional groups of amino acids (e.g. mercapto group (SH-) of cysteine and guanidyl group (-NH-C/=NH/-NH2) of arginine).

Apart from sugars, their degradation products (very reactive products created e.g. during the production of protein hydrolysates – e.g. glycolaldehyde O=CH-CH2-OH or glyoxal O=CH-CH=O) and the degradation products of amino acids (amines, ammonia, aldehydes etc.), the reactions also involve carbonyl compounds present in foodstuffs as primary substances (e.g. aldehydes and ketones occurring in essential oils, ascorbic acid) and carbonyl compounds created in foodstuffs from precursors other than sugars (e.g. aldehydes created by fat oxidation).

Aldehydes created during fat oxidation (see the scheme) contribute to the aroma and taste of process flavourings (they are carriers of e.g. fried or grass-like taste and aroma of a product; however, they can also carry the undesirable rancid taste). Thanks to the linear molecule and the free aldehyde group, they are highly active in the non-enzymatic browning reactions. The products are similar to those in sugars, but the reaction speed is higher. Aldehydes are created during the oxidation of unsaturated fatty acids (containing one or more double bonds), which are the primary acids of most animal and vegetable fats.

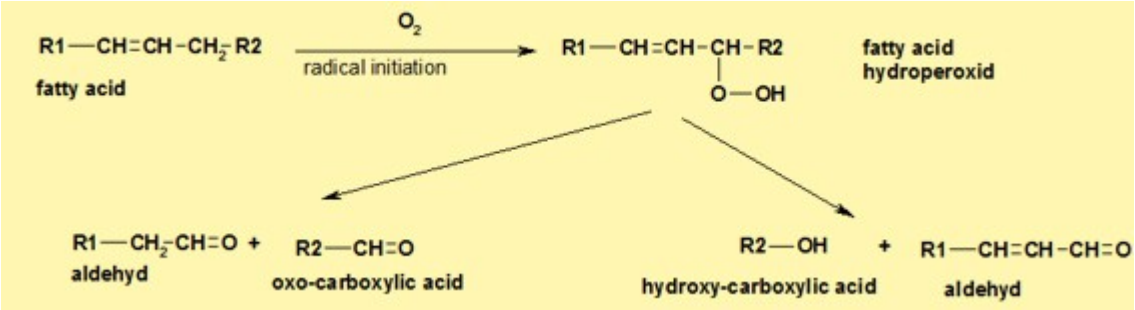
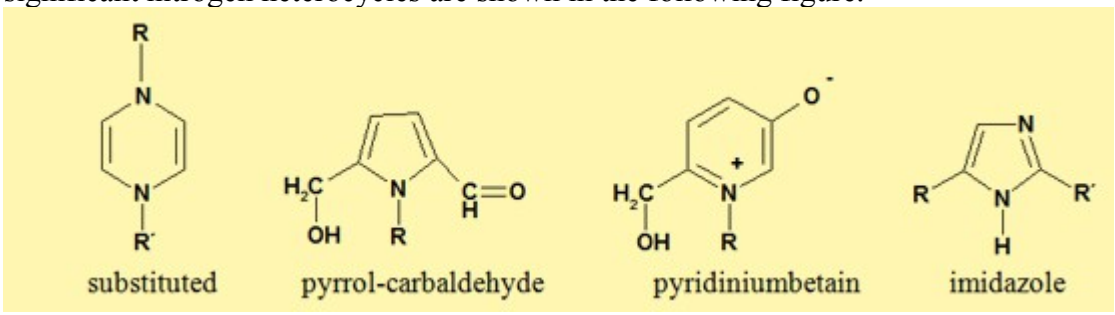


Fig. 3. Scheme of oxidation of an unsaturated fatty acid

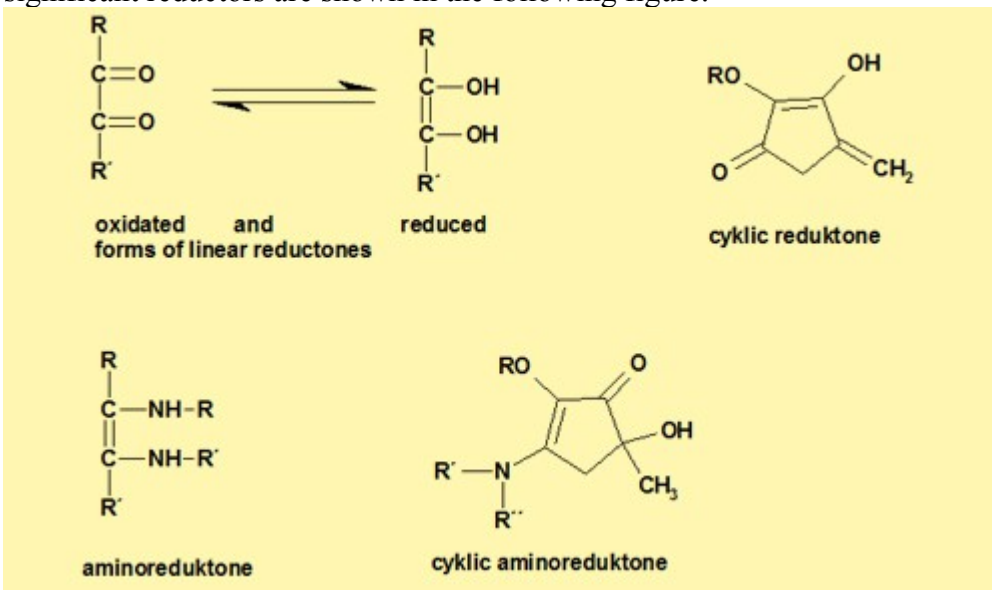
The Maillard reaction provides a broad range of various compounds that influence the product's sensorial and nutritional quality. These compounds can be divided into three basic groups:

1. Melanoidins: Coloured high-molecular (polymeric) products that give the product different colour shades from light yellow to dark brown. Their mild anti-oxidation activity is also important. Their quantity is largely dependent on the reaction conditions.
2. Aromatic substances of various types; the types of the created substances and their quantities depend on the reaction conditions and the initial materials. The structures of some significant nitrogen heterocycles are shown in the following figure.

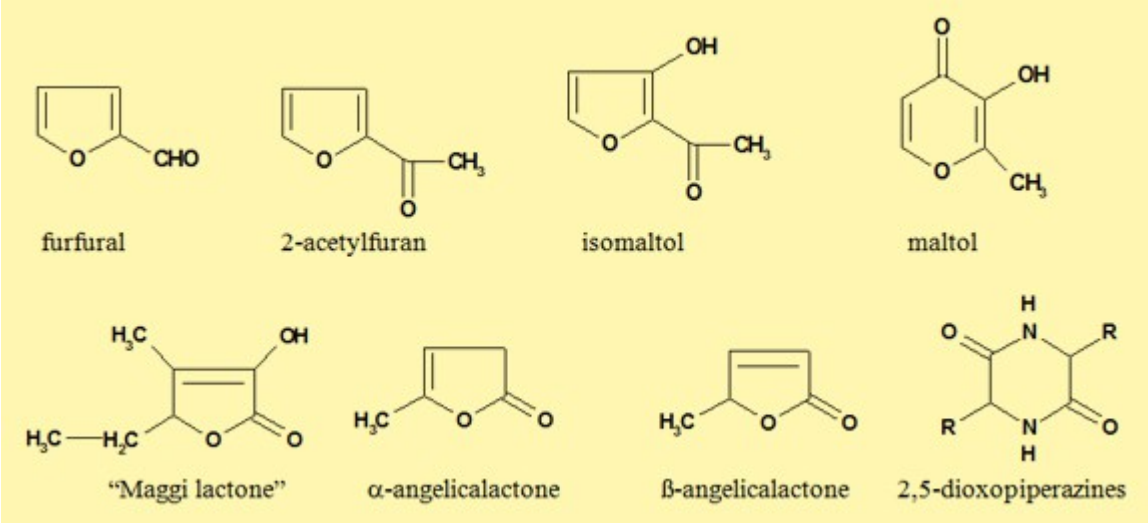


Other important flavour components created during the reaction are aliphatic aldehydes and other nitrous, oxygenous, sulphurous and mixed heterocycles – mostly five-membered and six-membered heterocycles.

3. 3.Other substances of different structures: they include e.g. degradation products of sugars (glyoxal etc.), reductones, premelanoidins and others. They mostly act as very reactive intermediary products, but at a low reaction speed (e.g. at lower temperatures) they can remain in the reaction mixture. Reductones are very strong antioxidants. Examples of significant reductors are shown in the following figure.



If the production involves protein hydrolysates, volatile substances created in the production of these hydrolysates are substantial components of the flavour. These are the degradation products of sugars in an acid environment, of which the most important are furan derivates (2-furaldehyd, 5-hydroxymethyl-2-furaldehyd and others), lactones (e.g. Maggi lactone, α- and β-angelicalactone), maltol, isomaltol and others. Heterocyclic nitrogen compounds are commonly created as products of non-enzymatic browning reactions.



Product aroma and quality

The progress of the reaction, the types and the quantities of the reaction products largely depend on the reaction conditions and the initial components. The reaction is mostly influenced by temperature, which accelerates it significantly. However, temperatures exceeding 120°C already have a negative impact:

- The intensity of the product's colour is too high
- The intensity of the sugar caramelisation increases significantly, which brings about negative changes in the flavouring and a bitter taste of the product
- The quantities of some flavourings are too high, which results in a too single-sided taste and flavour of the product.

The illumination of the input materials and the product may also have some influence, as it may accelerate certain reactions. An excessively intensive illumination may, however, result in a higher increase in the flavourings associated with fat oxidation, which would also have a negative impact.

A well-managed technology of process flavourings should lead to the following positive sensorial perception of taste and aroma:

- meaty
- malted
- bread-like – roasted breadcrumbs
- caramel – should not be dominant in any case
- fried – should be very fine, complementary
- roasted
- coffee-like.

In general, the shares of the individual tastes and aromas should be balanced, none of these tastes and aromas should dominate. The conformity to this requirement should give the product a full, harmonious taste and aroma.
A very mild grass-like and chocolate aroma and a very mild acid taste are also acceptable.

Unsuitable production conditions could result in the creation of flavourings whose taste and aroma

have to be evaluated negatively. They include:

- o acrid, biting taste and aroma – often caused by the free acrolein (CH2=CH-CH=O), which may be generated in smaller quantities from methionine amino acid. Larger quantities are generated through the dehydration of glycerol when fat is overburnt
- Burnt aroma – created in case of an excessive temperature or too intensive fat oxidation
- Bitter taste – created in case of a very high temperature due to excessive sugar caramelisation
- Onion taste and aroma; cabbage aroma – created usually if an unsuitable initial material containing many sulphur compounds is used
- Rancid taste and aroma – generated in case of an excessive fat oxidation and the simultaneous low speed and quick end of the reaction. This could be a problem of process flavourings products at lower temperatures
- Odour of solvents, sweet taste – could be generated at lower speeds and quick end of the reaction. This could be a problem of process flavourings produced at low temperatures.

Input materials for the production of process flavourings

Depending on the required taste and aroma of the end product, the following types of initial materials are usually used:

Sources of proteins and amino acids:

- protein hydrolysate (HVP)
- extracts from pork, beef, mutton or poultry – liquid or powder
- concentrates of yeast proteins
- concentrates of vegetable proteins – mostly from soy
- extracts from the meat of sea animals.

Sugars
Glucose and more often dextrose, but also xylose

Fats
Do not have to be always used, but make the product's taste and aroma finer and fuller. Vegetable fats and oils are used, just like animal fats as well as fish oils. Fish oils, but also vegetable oils, are often quite prone to excessive oxidation and technology employing these oils has to be conducted very carefully.

Other commonly used additives

- sodium glutamate (MSG) – used very often to add additional flavouring to the product. It has a very distinct "glutamate" taste, which could lead to the undesirable unification of tastes of different products if used too frequently
- nucleotides: The most frequent is inosine monophosphate (IMP), which acts as a strong meat flavour intensifier.

Other additives
Many other additives are used sometimes to flavour the product and improve its texture.
They include:

- acidulants – lactic, citric, malic, tartaric, succinic and fumaric acids
- sodium chloride – gives the product a salty taste and acts as a carrier and a filler
- fillers – Arabic gum, silica, bicarbonate
- carriers of functional aromatic substances – starch, modified starch, maltodextrins.

All of the additives used are absolutely harmless in terms of food safety and are used commonly in the food-processing industry. What is a problem in this case is a "mental allergy" of consumers to

any additives, which makes most producers limit their utilization.

Conclusion

Process flavourings are products of a purely natural origin. They constitute the most important input material for the preparation of different flavouring substances, aromatic mixtures and seasoning products used in foodstuffs that can have a large effect on the sensorial quality of the final meal. They are also used as the fundamental aroma for the preparation of bouillons, instant soups, gravies and sauces, which are currently highly preferred by consumers.

The product's taste and aroma depend on the input materials and reaction conditions. This choice makes it possible to obtain mixtures of aromatic substances of different profiles that which can be used for the production of foodstuffs and as a part of composite seasoning mixtures.