Hydroxymethylfurfural (HMF) Analytical method established at LCI

Lebensmittelchemisches Institut (LCI) des Bundesverbandes der Deutschen Süßwarenindustrie e.V.

Department Head:
Prof. Dr.
Reinhard Matissek

Adamsstraße 52 - 54
51063 Köln

phone
+49 221 62 30 61
fax
+49 22 61 04 77
web
www.lci-Koeln.de

What is HMF and how is it generated?

HMF (5-hydroxymethyl-2-furfural) is an aldehyde-furan compound that occurs in many carbohydrate-containing foods during thermal treatment – hence also in household food preparation through boiling, frying, or baking. It arises either via a dehydration of hexoses (monosaccharides with six carbon atoms, e.g. glucose, fructose, etc.) in an acidic environment or can occur – just like the well-known process contaminant acrylamide – during the Maillard reaction (cf. also LCI-Focus 05/2003: Die Maillard-Reaktion). In addition to temperature, the parameters pH value and water activity also affect the reaction. HMF was discovered in 1912 by the French chemist Louis Maillard during his research into reactions between glucose and lysine (hence lending his name to the Maillard reaction).

HMF is thus contained in numerous foods such as honey, fruit juices, coffee, bakery wares, and caramel, as well as in heat-treated milk and alcohol beverages. The content levels found in bread, for example, range between 3 and 220 mg/kg. A particular case in point are prune juices, which can have exceptionally high HMF content levels of up to 2850 mg/l.

What makes the analysis of HMF in foods interesting?

From a food technology point of view, HMF represents a key heat treatment indicator. In honey, for example, which has a naturally low pH value and contains reducing sugars, a certain amount of HMF occurs even at room temperature. However, content levels are significantly increased by heat treatment or a long storage period. The EU has set an HMF tolerance limit of 40 mg/kg for honey produced under European conditions. In addition to honey, fruit juices are also a case where a high HMF content level is taken as an indicator for technologically preventable heat exposure. What is more, foods to which caramel products are added as colouring agents and flavourings can also have high HMF levels.

In addition, HMF must also be considered from a toxicological point of view as it is suspected of having mutagenic and genotoxic effects.

Toxicology

In a statement dated 15 May 2011, the Federal Institute for Risk Assessment (BfR) concludes that HMF intake represents little or no risk. According to this position paper, the acute toxicity of HMF is deemed very low. Studies on carcinogenicity showed no changes for an intake of 80-100 mg/kg body weight per day. Various food consumption surveys estimate that HMF intake levels lie between 4 and 30 mg/day, these being strongly dependent on people's respective dietary habits. Hence the current exposure level leaves a sufficiently large safety margin. It is known that the HMF metabolite SMF (5-sulfooxymethylfurfural), not HMF itself, has mutagenic potential. Whether this metabolite can occur in the human body is currently unsubstantiated. The Federal Institute for Risk Assessment (BfR) hence classifies its carcinogenicity as being undetectable or low. However, this finding is qualified by the fact that only a limited number of corresponding studies have been carried out to date, meaning that the data is still too uncertain to set an ADI level. What is more, no research has yet been carried out to determine whether it can have toxic effects for reproduction.

Analytical Techniques

With a maximum absorption of 284 nm, HMF can readily be analysed via HPLC and UV detection after aqueous extraction. Spectrophotometric methods are also possible, with possible interference, especially in the case of strongly coloured foods. In addition, GC/MS, capillary electrophoresis, and ion chromatography are also used.

At the LCI, a method for analysing HMF has recently been developed and validated within the scope of a Master's thesis. This analytical method can now be commissioned from our sister institute IQ. Köln (Institute of Quality Promotion in the Confectionery Industry) in Cologne (contact: iq-koeln@iq-koeln.de). SV