Update on Furan and its Methyl Analogues

Furan (derived from the Latin word for bran, furfur) is, in pure form, a colourless and volatile liquid that is also known under the names divinylene oxide, oxacyclopentadiene, and oxole. This compound, belonging to the group of oxygen-containing heteroaromatics, is insoluble in water but highly soluble in organic solvents such as alcohol, ether, and acetone. Furan is used in the chemistry industry to manufacture chemicals, resins, and paints.

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What are the methyl analogues of furan?

Generally speaking compounds are described as "analogues" if they have molecular or functional similarities to another compound. The methyl analogues of furan, such as 2-methylfuran, 3-methylfuran and 2,5-dimethylfuran (cf. figure 1), hence have the basic structure of furan with one or several methyl (CH_3) groups at different positions.

These, and furan, have been detected in heat-treated commercial foods. They can occur during the food preparation process or may also be added to foods as flavourings.

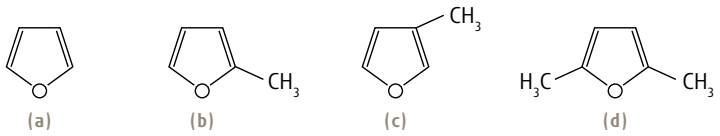

Figure 1: Structural formulas of furan (a), 2-methylfuran (b), 3-methylfuran (c) and 2,5-dimethylfuran (d)

The pertinent literature describes several formation paths via which furan is generated in heat-treated commercial foods. Accordingly, furan can be generated via the Maillard reaction process by way of the degradation of amino acids and reducing sugars. In addition, it may also be generated by the thermal oxidation of ascorbic acid, carotenoids, and by the lipid oxidation of polyunsaturated fatty acids.

Where do furan and its methyl analogues occur?

In addition to the presence of furan in cigarette smoke, its occurrence in heat-treated commercial foods has been described for several years now. Particularly high content levels have been detected in roasted coffee and in foods heat-treated in sealed containers, such as canned meats, soups, and vegetables. Furan has also been detected in baby foods, bakery wares, sauces, bread, and beverages.

According to estimates, 85% of the furan ingested by adults comes from coffee, whereas children are more greatly exposed through bottled baby foods and an intake via fruit juices.

Can furan and its methyl analogues pose a health risk?

In 1995, furan itself was already classified by the International Agency for Research on Cancer (IARC) as possibly carcinogenic to humans (category 2b). An epoxidation takes place within the course of metabolisation, followed by a ring opening and generation of a reactive 2-ene-1,4-dicarbonyl intermediate.

In a report submitted by the CONTAM Panel of EFSA (European Food Safety Authority), it was also established that there was only a small difference between human exposure to furan and the dose that causes carcinogenic effects in animal studies.

As regards the methyl analogues 2-methylfuran and 2,5-dimethylfuran, the toxicological EFSA assessment of a number of aromatising, furan-like substances also raised concerns about a possible genotoxicity. Given the structural similarity and the lack of other metabolisation paths, such as hydrolysis or conjugation, a metabolisation mechanism analogous to furan can occur. In addition, an oxidisation of the alkyl-substituted compounds at the C1 atom may result in a ketone. For one of these ketones, EFSA also has data suggesting a genotoxic potential.

Given the partially insufficient data availability regarding toxicology and exposition, the European Commission has asked EFSA to provide a scientific opinion on the risk of the presence of furan and its methyl analogues in food intended for human consumption. Within the course of the latter, data was gathered on the occurrence of furan, 2-methylfuran, 3-methylfuran and 2,5-dimethylfuran in foods at the end of 2016.

How are furan and methylfurans analysed?

Given the volatility of furan and the methylfurans, analysis is conducted using headspace gas chromatography-mass spectrometry (headspace GC MS) or solid phase microextraction GC MS (SPME GC MS). For the purpose of quantification, either an internal fourfold-deuterated furan standard or an external calibration can be used. Difficulties or error sources when conducting an analysis arise particularly from the volatility of the furan molecule and from the observation that, under certain conditions, furan may be generated during the analysis procedure.

Do maximum levels exist for furan and methylfurans in foods?

So far no maximum levels have been set either for furan or for methylfurans in foods. However, given the toxicological assessment of 2-methylfuran and 2,5-dimethylfuran, the flavouring industry has decided to no longer support the use of these two compounds as flavourings in Europe. SV