
REPORT ON SMOKE FLAVOURINGS

ADOPTED ON 25 JUNE 1993

1. Foreword

The EEC "framework" Directive on Flavourings (1) contains a category of flavourings entitled "Smoke Flavourings". It also stipulates that further appropriate provisions should be adopted to ensure the safety of flavourings used or intended for use in or on foodstuffs to impart odour and/or taste.

In the preliminary opinion of the Scientific Committee for Food given at its 73rd meeting on 18 May 1990 it was stated:

"The Committee (also) noted the absence of inventories on smoke flavours.

The Committee concluded that a safety evaluation of flavours should be performed and that an inventory of flavours in use together with information on usage would be needed for this purpose".

As stated in its GUIDELINES FOR THE EVALUATION OF FLAVOURINGS FOR USE IN FOODSTUFFS: 1. CHEMICALLY DEFINED FLAVOURING SUBSTANCES (2) adopted at the 81st Plenary Meeting 9-10 December 1991, the Committee emphasises that before an additive is accepted for use in food it should have been subjected to an adequate toxicological evaluation. In that context the Committee intends among other tasks to address the issues of the evaluation of flavourings categorised as smoke flavourings. As the Directive does not cover the process of smoking only general technical aspects of it will be addressed in this report.

In elaborating the present document the Committee has drawn extensively on the Council of Europe documents (3,4) and on the assessment of some smoke flavourings by JECFA (5).

2. General considerations

Smoking is next to drying and salting of food perhaps the oldest process for preserving and flavouring food. It has been probably in use since man knew fire for about 90 000 years and possibly longer. The original primary objective to preserve food is achieved by dehydration and by diminishing the number of surface bacteria through the action of certain components of the smoke and thus to enhance its keeping qualities. The secondary objectives of imparting desirable structural and sensory alterations such as smoke colour and smoke flavour to the final product serve to make the smoked food attractive to the consumer. Today smoking is primarily used for organoleptic purposes.

Hard woods are commonly used in the traditional smoking process occasionally with added aromatic herbs, spices and twigs of certain plants. Food is then exposed directly or indirectly to the generated smoke.

Smoke flavour can be imparted to food also by the use of smoke flavourings with acceptable organoleptic properties and processed to eliminate undesirable components such as PAHs. These smoke flavourings are intended for direct use in or on food and are therefore regarded as food additives.

3. Technological considerations

Although not within the ambit of the Directive, it is considered useful to include a brief discussion of the process of smoking in this section.

3.1 Smoking with freshly generated smoke from pyrolysed wood or moist wood chips

In the direct conventional smoking of food the components of the smoke attach to the surface of the exposed food by chemical and physical processes, e.g. condensation, adsorption, adhesion. The deposited smoke components subsequently penetrate into the treated food to a variable depth, depending on the nature of the food. As a result the smoked food becomes contaminated, albeit in small amounts, with components of the smoke, such as polycyclic aromatic hydrocarbons (PAH), phenols and formaldehyde, which may be hazardous to health. As smoking is difficult to control and standardize, it is necessary to develop smoking techniques which optimise the desirable effects of smoking and avoid, as far as possible, any of its adverse effects.

Commercial smoking processes use various types of smoke generators in which a controlled combustion of wood takes place. Wood is either pyrolysed yielding fumes which on oxidation form smoke, or moist wood chips are heated to generate smoke directly. Hard woods are commonly used in the traditional smoking process but it is essential that only specified, acceptable types of natural wood are used. The following table sets out some examples and is not meant to be exhaustive:

List of examples of untreated wood, bark and twigs for the generation of smoke

Acer negundo L.	Maple tree
Betula pendula Roth.	White birch
B. alba L. and B. verrucosa Ehrh.	
Betula pubescens Ehrh.	European birch
Carpinus betulus L.	Hornbeam
Carya ovata (Mill.) Koch	Hickory
Castanea sativa Mill.	Chestnut tree
Eucalyptus sp.	Eucalyptus
Fagus grandifolia Ehrh.	Beech
Fagus silvatica L.	Beech
Fraxinus excelsior L.	Common ash
Juglans regia L.	Walnut tree
Malus pumila Mill.	Apple
Prosopis juliflora DC.	Mesquite wood
Prunus avium L.	Cherry tree
Quercus alba L.	White oak

Quercus ilex L.	Holm oak
Quercus robur L.	Common red oak
Rhamnus frangula L.	Alder Buckthorn
Robinia pseudoacacia	Black locust
Ulmus fulva Michx.	Sweet elm
Ulmus rubra Mühlenb.	Elm

Herbs and spices may also be added, as well as twigs of Juniper and twigs, needles and cones of Picea.

To minimize the presence, particularly of PAHs, in traditionally smoked foods the direct contact of the food with smoke can be avoided by the introduction of indirect smoking processes. Other measures to reduce the transfer of toxic components to the food being smoked include the interposition of cooling traps, washing filters and spatial separation from the smoke source. Every one of these modifications can however affect adversely the organoleptic results. PAH production can be reduced by keeping the smoke generation temperatures below 400°C, by filtering off the particulates, by wrapping products in casings impermeable to PAH, and by reducing the duration of smoking if the surface/weight ratio is high. However the smoking time depends largely on the product to be treated and the flavour to be achieved. The introduction of smoke flavourings now permits the reduction of contamination with hazardous compounds and enables accurate control of flavour intensity in the final product.

3.2 Smoke flavourings

Smoke flavourings may be divided into the following three types: Smoke condensates, smoke flavours prepared by mixing chemically defined flavouring substances, and smoke flavouring preparations. The latter are based on smoke condensates or on smoke flavours prepared by mixing chemically defined flavouring substances with the addition of other substances.

Smoke condensates are traditionally based on three ways of fixing smoke:

Firstly, smoke is trapped in water or possibly other liquids, e.g. alcohol/water mixtures or oil. These condensates are usually further processed, e.g. fractionated by extraction. The aqueous smoke condensates, from which the tarry organic phase containing the PAHs has been removed, are the commercially most important products.

Secondly, smoke may be condensed to yield whole smoke condensates. They are obtained as pyroligneous acid products by the dry distillation of certain hard woods at 200-900 °C in the absence of air or in the presence of limited air, or from steam distillation at 100-400 °C with or without pyrolysis. These whole smoke condensates may be further processed e.g. by dilution with water to separate off the tarry phase combined with adjustment of the phenolic content or by the fractionally distilling the tarry part and recombining the purified acid, phenolic and neutral fractions in various patented proportions. These types of products are however of little commercial interest.

Thirdly, smoke is condensed on solids, e.g. sugar, salt, maltodextrins, meat, or bacon rind, which may be subsequently extracted with certain solvents.

Smoke condensates are complex mixtures of variable composition and contain different amounts of a spectrum of compounds, e.g. carboxylic acids, ketones, furfural derivatives, lactones, and phenols (7,8). The likely most hazardous constituents are the PAHs, the total amount of potentially harmful PAHs other than benzo(a)pyrene being 5 to 10 times the amount of benzo(a)pyrene found (6).

Smoke condensates prepared from smoke trapped in liquids, usually water, are separated from the tarry phase. The aqueous phase is then usually purified by filtration through charcoal and concentrated by distillation for the preparation of smoke flavours.

Smoke condensed on solids, e.g. sugar, salt, meat or bacon rind, may be used as such or extracted with alcohol, methanol or other solvents and then purified by charcoal filtration and concentrated by distillation. Those products are not widely used and are therefore of minor commercial importance.

The final smoke flavour preparations are usually formulated by adsorption of the condensate on a carrier, or by spray drying, or by incorporation into solvents or emulsions. They are applied to the surface of or mixed into food products and are not normally incorporated into curing salt preparations. Smoke flavouring preparations may be incorporated into food usually at concentrations from 0.1% to 1%.

4. Toxicological considerations

As previously pointed out, the process of smoking is difficult to standardize and to control. As it is not covered by the Directive, no specific toxicological considerations have been developed for the evaluation of the safety of the process of smoking.

4.1 Contaminants

It is essential that woods treated with paint or impregnated with tar or wood preservatives including pesticides, e.g. arsenicals, chlorinated phenols, must be excluded as raw materials for smoke generation. Herbs, spices and twigs of certain plants may, however, be added for special flavouring properties.

Furthermore, because smoke flavourings are intended to be added deliberately to the food, they must comply with the following maximum limits for contaminants* :

Benzo(a)pyrene 10 µg/kg condensate (solvent/water free) giving rise to less than
0.03 µg/kg final foodstuff as consumed

Benzo(a)anthracene 20 µg/kg condensate (solvent/water free) giving rise to less than
0.06 µg/kg final foodstuff as consumed

As 3mg/kg, Hg 1mg/kg, Cd 1mg/kg, Pb 10mg/kg smoke condensate.

4.2 Principles of toxicological evaluation

Smoke flavourings need to be evaluated as any other food additive.

Smoke flavouring preparations, based on mixtures of chemically defined substances, require no further assessment of their safety, provided the individual components have been evaluated previously and accepted as flavouring substances for foodstuffs. However, any components, which have not been evaluated previously, require the usual establishment of their safety to health as flavouring substances prior to their use (see Guidelines for the safety evaluation of flavouring substances (2)).

Because of the wide physical and chemical differences in the preparations used for imparting a smoke flavour to food, it is not possible to design a common approach to the safety assessment of smoke flavourings. However, the existing multitude of individualised smoke flavouring preparations is based on only a limited number of commercially available smoke condensates mainly of the aqueous type.

The SCF considered, as did JECFA (5), that ADIs cannot be allocated to such a complex group of substances and that other ways of establishing their safety have to be chosen. Only some well specified aqueous condensates and one tarry extract of a smoke condensate, prepared from a specific wood, have been tested in standard toxicological studies and evaluated by JECFA as provisionally acceptable for use as a flavouring in foods otherwise traditionally treated by smoking.

In the opinion of the SCF the toxicological evaluation should therefore concentrate on the safety of smoke condensates on a case by case basis.

* The maximum limits for 3,4-benzpyrene of 0.03 µg/kg foodstuff and 0.03 µg/kg beverage are set out in Council Directive 88/388/EEC (1).

The following technological information is a prerequisite for the safety evaluation of smoke flavourings:

- information on the production method of the smoke condensate, the further processing, and the final steps in the production of the flavouring preparation;
- approximate qualitative and quantitative composition of the smoke condensate as well as the concentration used and similar data on the final smoke flavouring preparation;
- information on the use levels and the kind of foods for which the smoke flavouring is intended;

The core set of toxicological data on the smoke condensate or the individual derived smoke flavouring preparation should comprise:

- an *in vitro* mutagenicity test in a prokaryotic system;
- an *in vitro* gene mutation test in cultured mammalian cells;
- an *in vitro* test for chromosomal damage in cultured mammalian cells;
- a 90-day feeding study in laboratory animals.

Additional toxicological data may be required for assessment of the safety of the smoke flavourings as necessary. Here a stepwise approach may be used, depending among other things on the potential intake and the results of the core set of toxicological data.

References

1. Directive of 22 June 1988 on the approximation of the laws of the Member States relating to flavourings for use in foodstuffs and to source materials for their production (88/388/EEC, OJ L184 of 15.07.1988).
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4. Health aspect of using smoke flavours as food ingredients (Council of Europe Press - 1992).
5. Evaluation of certain food additives and contaminants. Thirtyfirst meeting of the Joint FAO/WHO Expert Committee on Food Additives. WHO Food Additives series, no. 22—1988 (Distributed by Cambridge University Press).
6. Phenole im Räucherrauch - Nachweis und Identifizierung by Reiner Wittkowski. Deutsche Forschungsgemeinschaft - Wissenschaftliche Arbeitspapiere, 1985.
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