codex alimentarius commission

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WORLD HEALTH ORGANIZATION

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CODEX COMMITTEE ON FOOD ADDITIVES AND CONTAMINANTS

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DISCUSSION PAPER ON POLYCYCLIC AROMATIC HYDROCARBONS (PAH) CONTAMINATION

(prepared by Denmark with the assistance of the European Community, Finland, Iceland, India, Japan, Korea, United Kingdom, the United States and IADSA)

Governments and international organizations in Observer status with the Codex Alimentarius Commission wishing to submit comments on the following subject matter are invited to do so **no later than 31 January 2006** as follows: Netherlands Codex Contact Point, Ministry of Agriculture, Nature and Food Quality, P.O. Box 20401, 2500 E.K., The Hague, The Netherlands (Telefax: +31.70.378.6141; E-mail: info@codexalimentarius.nl - ***preferably***), with a copy to the Secretary, Codex Alimentarius Commission, Joint FAO/WHO Food Standards Programme, Viale delle Terme di Caracalla, 00100 Rome, Italy (Telefax: +39.06.5705.4593; E-mail: Codex@fao.org - ***preferably***).

INTRODUCTION

1. At the thirty-sixth session of the Codex Committee on Food Additives and Contaminants (CCFAC), the Delegation of Denmark proposed to develop a Code of Practice for the reduction of contamination of food with polycyclic aromatic hydrocarbons (PAH) during food processing. In noting that these substances would be evaluated by JECFA in 2005, the Committee considered it premature to start elaboration of a Code of Practice and agreed to develop a discussion paper to set out the issues concerning PAH in foods for the 37th session of the CCFAC (ALINORM 04/27/12, para. 217).

2. This discussion paper was discussed at the thirty-seventh CCFAC, and the Committee agreed to revise the discussion paper in a working group led by Denmark, with the assistance of the European Community, Finland, Iceland, India, Japan, Korea, United Kingdom, the United States and IADSA. It was agreed that the discussion paper should include an outline of a Code of Practice (see the draft outline in Annex III), mainly focusing on general advice addressing practices that may lead to high levels of PAH in foods, and it should include a project document for starting new work on the elaboration of the Code of Practice (see Annex IV) (ALINORM 05/28/12, paras 199-200).

SCOPE

3. The general purpose of the Codex Alimentarius (through the Codex Standards) is to protect consumers' health while ensuring fair practice in the food trade.

4. PAH constitute a large class of organic compounds containing two or more fused aromatic rings made up of carbon and hydrogen atoms. Hundreds of individual PAH may be formed and released as a result of incomplete combustion or pyrolysis of organic matter, during industrial processes and other human activities, including processing and preparation of food and carbonization of wood to make charcoal. As some of the PAH are carcinogenic and mutagenic substances, the purpose of this discussion paper is to provide the background for a discussion at CCFAC on ways to reduce contamination of foods with PAH during processing. This discussion paper also includes a draft outline for the proposed Code of Practice and a proposal for new work for Codex (Annexes III and IV).

5. From the data reviewed by the SCF, cereals and vegetables, and fats and oils were the major contributors to PAH in the diet, with grilled/smoked / barbequed fish and meat making a relatively low contribution except in cultures where they are a significant part of the diet.

6. As cereals and oil seeds can have a major impact on PAH intake from food there could also be need to control the levels of PAH in agriculture crops post-harvest, with particular reference to storage and drying procedures.

7. The scope of the discussion paper is restricted to contamination of food with PAH from processing and not to the contribution from environmental contamination. PAH contamination in the environment as a source of PAH in food should be covered either by source directed measures like filtering smoke from the relevant industries or limiting the exhaust of PAH from cars. Good agricultural practices (GAPs), when growing crops and when selecting appropriate farmland, could also decrease the environmental contamination of foods with PAH. Some information on PAH contamination in the environment can be found in Annex I.

BACKGROUND

8. PAH are contaminants in food. Sources of PAH are contamination[1] from food processing or from the environment.

9. Most of the Codex Commodity Standards have limits for many contaminants such as heavy metals, but not on contaminants in general. The Codex Committee on Fish and Fishery Products discussed a draft standard for smoked fish, which may contain PAH, at its twenty-eight meeting, 2005 (step 3) (ALINORM 05/28/18**)**. However, PAH are not specifically covered by the current version of this standard or by the other existing commodity standards.

FOOD PROCESSING TECHNIQUES THAT PRODUCE PAH

10. PAH may be formed during processing both in the industry and in domestic food preparation, such as:

- Smoking,
- Drying,
- Cooking (Roasting, baking, frying and barbecuing/grilling).

Among the cooking processes, grilling/barbecuing contributes ~~to~~ the highest levels of PAH in foods and will be discussed in more detail below.

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[1] *Contaminant* is defined as "Any substance not intentionally added to food, which is present in such food as a result of the production (including operations carried out in crop husbandry, animal husbandry and veterinary medicine), manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food or as a result of environmental contamination. The term does not include insect fragments, rodent hairs and other extraneous matter." (Codex Alimentarius, Procedural Manual, 14th edition 2004).

11. Although not precisely known, it is likely that there are several pathways of PAH formation such as pyrolysis of melted fat dripping onto a heat source (as in barbecuing) and pyrolysis of food as a result of cooking temperatures above 200°C.

12. A number of variables, including cooking method (grilling, frying, roasting), time, and fuel, as well as the distance between the food and the heat source and drainage of fat, affect the formation of PAH. For example, a comparison of PAH levels in duck breast steaks undergoing various processing and cooking treatments for 0.5 hour to 1.5 hours, showed that charcoal grilled samples without skin contained the highest amount of total PAH (320 µg/kg), followed by charcoal grilling with skin (300 µg/kg), smoking (210 µg/kg), roasting (130 µg/kg), steaming (8.6 µg/kg), and liquid smoke flavouring (0.3 µg/kg (EU SCF, 2002)).

Smoking

13. Traditional smoking of foodstuffs such as meat and fish products and some types of cheeses has been used for centuries in many countries. Originally the purpose was to preserve the food, partly by drying and partly by adding anti-microbiological constituents such as phenols from the smoke to the food. Smoking is now primarily used to achieve the characteristic taste and appearance of smoked food with preservation playing a minor role. However, smoking has an influence on the shelf life of food because the smoke may inhibit growth of some microorganisms depending on the contents of some components like phenols in the smoked food.

14. Differences in traditional smoking processes result in highly variable data on PAH levels in smoked foods (EU SCF 2002). Factors that contribute to this variability include

- The type and composition of wood and herbs used to smoke foods,
- Use of direct or indirect smoking,
- Use of a washing/water cooling procedure after the smoking process,
- The type of generator used,
- The accessibility of oxygen
- Temperature, and
- Smoking time.

15. *Direct smoking* is the type of smoking process where the smoke is developed in the same room as the food is processed; *indirect smoking* uses smoke generators and the smoke is developed in a separate room and lead into the smoking chamber.

16. As an example of the effect that differences in smoking process can have on PAH levels, the content of 12 PAH in smoked fishery products from modern smoking kilns that use external smoke generation and have procedures in place to remove compounds with high boiling points such as PAH and particles potentially containing PAH has been compared with products from traditional smoking kilns where the smoke is generated in direct contact with the product. The average benzo [*a*] pyrene concentration determined was 1.2 µg/kg for the traditional kilns and 0.1 µg/kg for the modern kilns (EU SCF 2002).

17. The flavour of smoke can also be added to food by the use of smoke flavours. There are different types of smoke flavours; some flavours are extracted from smoke and others are mixtures of known chemicals. Both types of flavours, but especially flavours extracted from smoke, can contain PAH. As an example, the EU legislation on smoke flavourings has a limit on benzo[*a*] pyrene and benzo[*a*]anthracene in foodstuffs with added smoke flavour[2].

[2] *Smoke flavourings* are regulated under the EU directive for flavourings. The regulation includes a limit for the content in the flavour preparation/condensate on benzo(a)pyrene of 10 micrograms/kg and benz(a)anthrazene of 20 micrograms/kg, EC Regulation No 2065/2003 of the European Parliament and the Council of 10 November 2003 on smoke flavourings used or intended for use in or on foods.

Direct drying

18. Drying of food can take place either by *indirect* or *direct* drying processes. Indirect drying is not regarded as a source of PAH contamination, and will not be addressed in this paper.

19. Direct drying is used to dry grains, seeds, oils, milk powder etc. Common direct drying/heating operations and applications include drying to remove water (and/or other solvents/chemicals) added, left, or produced during processing. In direct drying, hot air is blown directly into the foodstuffs and combustion products can be led directly into the food. An example being direct drying of vegetable oils (including olive residue oils) where oil has been contaminated with PAH during technological processes.

20. The hot drying gases can be produced by using different types of fuel resulting in different types of contaminants in the air.

The heat energy of a system must:

- Heat the dryer feed to the vaporization temperature of the "light" components
- Vaporize and/or free the liquid/by-products above the solids' surface
- Heat solids to the final desired temperature, for the desired duration of time, and
- Heat the vapour to the final desired temperature.

Numerous factors, including equipment cost and availability of energy sources often result in similar foods being dried in very different ways.

Barbecuing or grilling.

21. Barbecuing or grilling are processes mostly used in the catering sector and in private homes. Barbecuing and grilling can produce high levels of PAH in foods. For example, a heavily barbecued lamb sausage contained 14 µg/kg of the sum of six PAH (of those considered by the EU SCF (2002) to be carcinogenic and mutagenic). PAH formation during charcoal grilling depends on the fat content of the meat, the duration of cooking and the temperature used.

22. The presence of PAH was studied in several samples of meat and fish that were grilled on horizontal and vertical gas barbecues. In contrast to a horizontal barbecue, the vertical barbecue prevented fat from dripping onto the heat source, and the PAH levels were 10-30 times lower than with the horizontal system.

LEVELS OF PAH IN SOME FOODSTUFFS

23. In the JECFA Summary report (Joint FAO/WHO Expert Committee on Food Additives, February 2005), the Committee note that they have not received any data on occurrence in the GEMS/food format. However, based on data from the European Union SCOOP task force and from IPCS reports, it was noted that the major foods containing higher concentrations of PAH are meat and fish products, particularly grilled and barbecued products, oils and fats, cereals and dry foods.

24. Some examples are given of the content of PAH in foods after processing of food such as drying and smoking and cooking of foods at high temperatures (grilling, roasting, frying):

- In uncooked foods the average background values are usually in the range 0.01 -0.1 µg/kg.
- In barbecued meat levels of the individual PAH, benzo[*a*] pyrene have been found as high as 157µg/kg.
- In traditional smoked food, an average of benzo[*a*]pyrene was 1.2µg/kg with a sum of carcinogenic compounds of 9µg/kg. For modern kilns the values were 0.1µg/kg and 4.5µg/kg respectively.
- A level of 10.7 µg/kg of benzo[*a*]pyrene as been reported in corn oil.

25. However, national studies has shown much higher concentrations, like e.g. in Finland[3] where in a study from 2003 the concentrations of benzo [a] pyrene varied from zero to 34 µg /kg and that of the total PAH compounds (19 compounds) from 42 to 9000 µg /kg. The study shows that the total PAH concentrations can be very high for instance in smoked meat products.

FOOD QUALITY AND NUTRIONAL VALUE

26. Traditional processing of food like smoking and drying provides a wider selection of foods and consequently a broader choice for the consumers. Many types of smoked or dried foods are well-estimated traditional food items where these types of processing have been used to prolong storage time and quality.

27. Processing of foodstuffs and extension of shelf life will often have an effect on the nutritional value of foodstuffs like the content of vitamins etc.

TOXICOLOGICAL CONSIDERATIONS

28. JECFA reviewed PAH in February 2005 (JECFA, Summary report, 2005). The Committee concluded that the critical effect of PAH is carcinogenicity. As a number of PAH are also genotoxic, it is not possible to assume a threshold mechanism and a PTWI could not be established. Most epidemiological data refer to occupational and environmental exposure. The available evidence regarding oral exposure to PAH was indirect and did not include data on quantitative exposure, and thus was not suitable for use in the risk assessment for PAH.

29. The present JECFA evaluation focused on 13 PAH that the Committee identified as being genotoxic and carcinogenic: benz [*a*] anthracene, benzo [*b*]fluoranthene, benzo [*j*]fluoranthene, benzo [*k*]fluoranthene, benzo [*a*]pyrene, chrysene, dibenzo[*a,h*]anthracene, dibenzo[*a, e*]pyrene, dibenzo[*a,h*]pyrene, dibenzo[*a,i*]pyrene, dibenzo[*a,l*]pyrene, indeno[1,2,3-*cd*]pyrene and 5- methylchrysene.

30. JECFA compared mean and high-level intakes of PAH with the calculated benchmark dose lower confidence limit for PAH and calculated margins of exposure (MOEs) of 25 000 and 10 000, respectively. The MOEs are based on available intake data, and can be a useful tool to prioritize risks. Based on these MOEs, JECFA concluded that the estimated intakes of PAHs were of low concern for human health.

31. JECFA noted that measures to reduce intake of PAH could include avoiding contact of foods with flames, and cooking with the heat source above rather than below the food. Efforts should be made to reduce contamination with PAH during drying and smoking processes, e.g., by replacing direct smoking (with smoke developed in the smoking chamber, traditionally in smokehouses) with indirect smoking. Washing or peeling fruits and vegetables before consumption would help to remove surface contaminants.

32. JECFA recommended that future monitoring should include, but not be restricted to, analysis of the 13 PAH identified as being genotoxic and carcinogenic, i.e. benzo[*a*]anthracene, benzo[*b*]fluoranthene, benzo[*j]*fluoranthene, benzo[*k*]fluoranthene, benzo[*a*]pyrene, chrysene, dibenz[*a,h*]anthracene, dibenzo[*a,e*]pyrene, dibenzo[*a,h*]pyrene, dibenzo[*a,i*]pyrene, dibenzo[*a,l*]pyrene, indeno[1,2,3-*cd*]pyrene and 5-methylchrysene. In addition, analysis of benzo[*c*]fluorene in food may help to inform future evaluations.

33. In the European Union, thirty-three PAH were evaluated by the Scientific Committee on Food (SCF 2002). Among these, 15, namely benzo[*a*]anthracene, benzo[*b*]-, benzo[*j*]- and benzo[*k*]fluoranthene, benzo[*ghi*]perylene, benzo[*a*]pyrene, chrysene, cyclopenta[*cd*]pyrene, dibenzo[*a,h*]anthracene, dibenzo[*a,e*]-, dibenzo[*a,h*]-, dibenzo[*a,i*]-, dibenzo[*a,l*]pyrene, indeno[1,2,3-cd]pyrene and 5-methylchrysene, show clear evidence of mutagenicity/genotoxicity in somatic cells in experimental animals *in vivo*. The most potent PAH appear to be compounds with a bay- or fjord region (Fig.1[4]).

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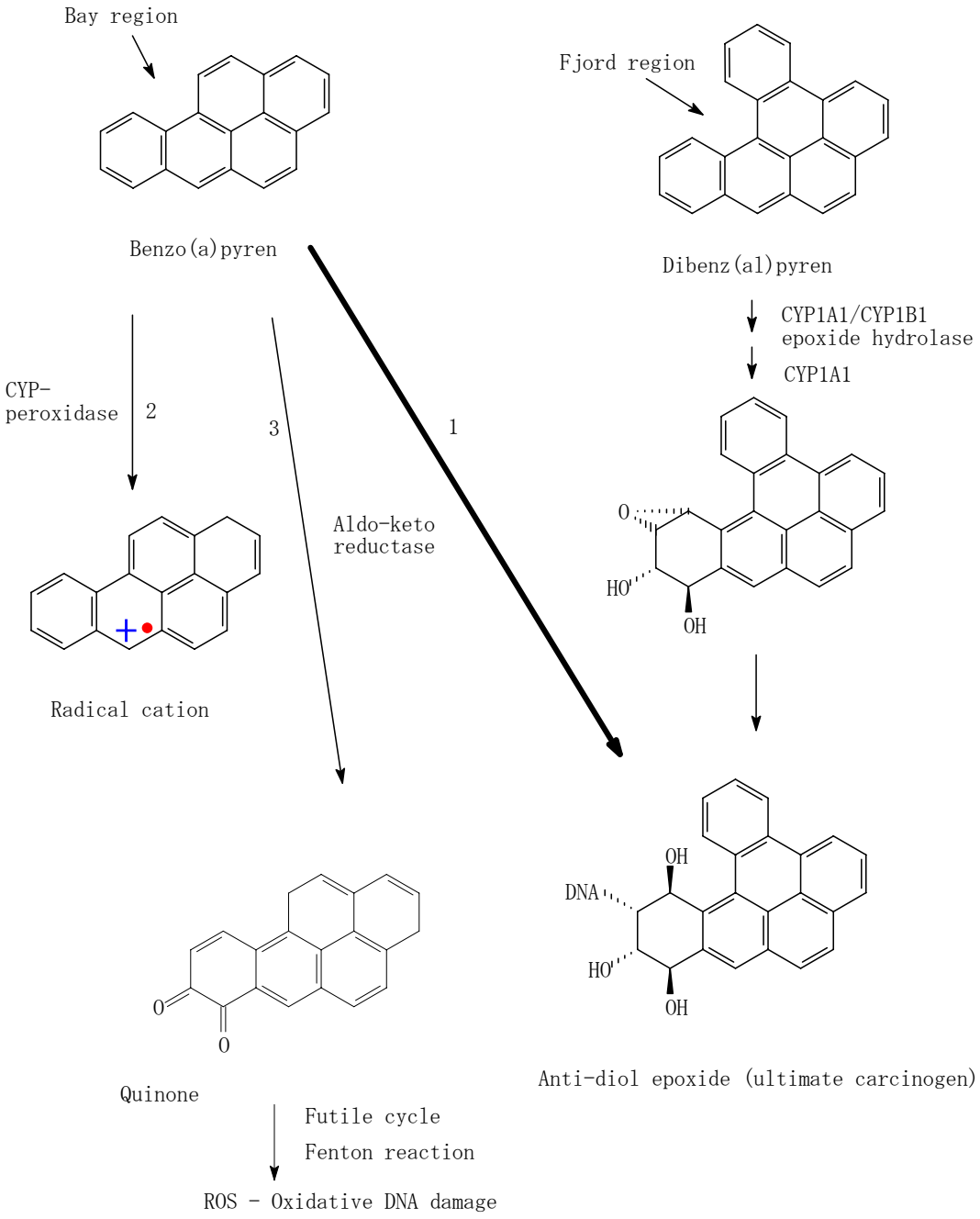
3 National Food Agency, Finland, 2003.

4 Binderup ML, Duedahl-Olesen L, Einarsson S, Fabech B, Haldorsen AL, Johnsson H, Knutsen HK, Müller AK, Vuorinen PJ, Wiborg ML. *The effect of oil spill on seafood safety.* Nordic council of ministers. TemaNord: 2004:553.

34. For most PAH, the carcinogenic potential constitutes the critical effect for the hazard and risk characterization. In general, the evidence of genotoxicity shows considerable overlapping with carcinogenicity in agreement with the mechanistic link between DNA adduct formation, mutations, and cancer outcome following PAH exposure.

35. With the exception of benzo[*ghi*]perylene, the15 genotoxic PAH (evaluated by the European Union Scientific Committee on Food) have also shown clear carcinogenic effects in various types of bioassays in experimental animals. Although only benzo[*a*]pyrene has been adequately tested using dietary administration, these compounds may be regarded as potentially genotoxic and carcinogenic to humans. They represent a priority group in the assessment of the risk of long-term adverse health effects following dietary intake of PAH.



MEASURES TO REDUCE PAH CONTAMINATION OF FOODS AND SOME RISK MANAGEMENT OPTIONS

36. Altering cooking or processing techniques can reduce the amount of PAH formed in foods. Alteration could be done in different ways, e.g., by using indirect drying or smoking processes, via the selection of fuel for drying or of wood species in the smoking and barbecuing process. Some examples of possible changes are given below.

Drying

37. Direct contact of oil seeds or cereals with combustion products during drying processes has been found to result in formation of PAH and should therefore be avoided, e.g., by use of indirect heating if possible.

Smoking

38. Replacing direct smoking with indirect smoking can significantly reduce contamination of smoked foods. An external smoke generator, which, in modern industrialized kilns, is operated automatically under properly controlled conditions like control on the addition of smoke, washing the smoke before bringing it into contact with the food etc.

39. Use of smoke flavourings is generally considered to be of lesser health concern than the traditional smoking process, as it may minimize PAH contamination. On the other hand, it might not be accepted by consumers to the same extend as the traditional used smoking process.

Barbecuing/grilling

40. Simple practices in barbecuing result in a significantly reduced PAH contamination of foods. These could be measures such as

- Selecting a ‘clean’ fuel. Thus, charcoal produces less PAH than e.g. wood, saw dust, paper, and cones
- Selecting lean meat and fish, and not fat meat and fish (lists names of fish species with fats content could be part of consumers advice)
- Preventing direct contact of foods with flames,
- Using less fat for grilling, and
- Cooking at a lower temperature for a longer time.
- Precook (par-cook) in microwave or boiling water to reduce time on grill, trim visible fat off meat

41. Fat should not drip down onto an open flame, which could send up a column of smoke to increase PAH contamination of the food. The use of medium to low heat and placement of the meat farther from the heat source can greatly reduce formation of PAH.

42. A management option for reduction of the content of PAH in barbecued food can be done via advice to the public such as

- “Use vertical barbecues instead of horizontal barbecues”
- “Don’t eat barbecued food too often”
- “Limit smoke formation by not letting oil drip on the charcoal”
- “Don’t eat burned food”.

43. The intensity of flavour is not necessarily associated with the depth of the brown colour of grilled foods. It is therefore not necessary to overcook the food to get the flavour. However, proper cooking temperature should be maintained to destroy food borne pathogens or endogenous toxins.

DISCUSSION

44. The paper describes sources of PAH during processing and provides some information on residue levels associated with the various types of processing, the chemistry involved, and the toxicology. However, more data is needed to illustrate the differences in PAH content in the different methods for processing.

45. The paper also discusses Good Manufacturing Practices and how evaluation of the potential contamination of the food coupled with the choice of processes could reduce the formation of PAH. However, the possible interplay among levels of contaminants like PAH, heterocyclic amines, and nitrosamines is not always well understood, and it should be emphasized that conditions that lead to a reduction of one contaminant might lead to increases in the levels of other contaminants or could lower the microbiological standard of the products.

46. With regard to direct and indirect smoking processes, direct smoking requires less equipment than indirect smoking but could result in higher levels of PAH in the smoked food. The use of smoke flavours might lead to lower levels of PAH in the food, but might not be accepted by consumers, even though the level of contamination of the final food could be less than after traditional smoking and the consistency and flavour are equal. The use of flavours does not necessary provide the preservative/anti-microbial effect of actual smoking. There may be microbial food safety reasons for traditional smoking of the product.

OPTIONS FOR DECISIONS

47. The use of processing should not contaminate food and endanger human health. At the same time, proper processing would reduce the level of microorganisms and improve the variety, the organoleptic properties and shelf life of food. Processes such as smoking have been used for centuries and smoked food is traditional food in many countries. However, consumer safety is highly important also in relation to smoked food and the content of PAH formed due to processing could be reduced while the microbiological safety is maintained.

48. Although JECFA concluded that PAH intake was of low concern to human health, based on a margin of exposure calculation, JECFA took note of the genotoxicity of these compounds and made recommendations as to how PAHs could be reduced in foods..

49. CCFAC should take initiatives to reduce the content of PAH contamination due to processing of food, taking into account that more information is needed before elaborating on a Code of Practice for reducing PAH contamination in food, including information on PAH formation and levels as a result of various food processing techniques (e.g., smoking, drying, barbecuing/grilling).

50. The challenge in dealing with PAH in foods is that there are environmental contaminants and contaminants from processes know to cause contamination and still being used in food preparation. When dealing with the processes that actively add contaminants, CCFAC is going to have to balance the toxicological safety concerns of PAH with traditional foods and food-borne disease safety concerns from microbial contamination. Sometimes the long-term risk is more acceptable than the short-term risk.

51. Some options are as follows:

a. CCFAC can develop a Code of Practice for reducing contamination of foods with PAH (i.e., reduce contamination from all routes, such as drying, barbecuing, etc.)

b. CCFAC can start to develop a Code of Good Manufacturing Practice for the use of direct drying to reduce contamination of foods with PAH

c. CCFAC can start to develop a Code of Good Manufacturing Practice for the use of the smoking process to reduce contamination of foods with PAH

d. CCFAC can start to develop a Code of Good Manufacturing Practice *both* for the use of direct drying and smoking of food to reduce contamination of foods with PAH

e. CCFAC can start to develop a Code of Good Manufacturing Practice to reduce contamination of foods with PAH for the use of barbecuing in the catering sector, including advice to consumers concerning barbecuing, and

f. CCFAC can examine Codex Standards on smoked and dried food to ensure that Good Manufacturing Practices have been described to minimize exposure to contaminants like PAH.

REFERENCES

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Commission. Levnedsmiddelstyrelsen: Røgning af levnedsmidler, Fabech, B. & Larsen, J.C, Publ. 135, 1986.

EU Regulation No 2065/2003 of the European Parliament and the Council of 10 November 2003 on smoke flavourings used or intended for use in or on foods

EU SCF (2002) Opinion of the Scientific Committee on Food on the risks to human health of polycyclic aromatic hydrocarbons in food. Scientific Committee on Food , European. website: http://europa.eu.int/comm/food/fs/sc/scf/out153_en.pdf

JECFA, Sixty-fourth meeting, 2005 Summary and Conclusions.

Annex I

Sources of environmental PAH contamination

Foods can be contaminated by PAH that are present in air (by deposition), soil (by transfer), or water (deposition and transfer). The sources, some natural but mostly anthropogenic, of PAH in the environment are numerous and include:

- Stubble burning
- Spreading of contaminated sewage sludge on agricultural fields
- Exhausts from mobile sources (motor vehicles and aircrafts)
- Industrial plants (e.g., aluminium foundries, incinerators)
- Wood preservation, use of tar coating
- Domestic heating with open fireplaces
- Burning of coal for thermal and electric energy
- Oil pollution of surface waters and soils
- Forest fires and volcanic eruptions

Vegetables may be contaminated by the deposition of airborne particles or by growth in contaminated soil. Meat, milk, poultry and eggs will normally not contain high levels of PAH due to rapid metabolism of these compounds in the species of origin. However, some marine organisms, such as mussels and lobsters are known to adsorb and accumulate PAH from water, which may be contaminated, for example by oil spills.

Example of a management option The contribution from some of these sources could be reduced if the potential problems are covered by good agricultural practices, e.g., not spreading contaminated sludge. The waxy surface of vegetables and fruits can concentrate low molecular mass PAH mainly through surface adsorption. The concentrations of PAH are generally greater on plant surfaces (peel, outer leaves) than on internal tissues. Consequently, washing or peeling may remove a significant proportion of the total PAH. Particle-bound, high-molecular-mass PAH that remain on the surface are easily washed off, whereas low-molecular-mass compounds that are in the vapour phase can penetrate the waxy layer of fruits and vegetables and are less efficiently removed by washing.

Annex II

Polycyclic aromatic hydrocarbons included in the JECFA Risk Assessment summary

Common name	CAS name	CAS Registry No.	Abbreviation
Acenaphthene	Acenaphthylene	83-32-9	AC
Acenaphthylene	Acenaphthylene, 1,2-dihydro-	208-96-8	ACL
Anthanthrene	Dibenzo[*def*,*mno*]chrysene	191-26-4	ATR
Anthracene	Anthracene	120-12-7	AN
Benz[*a*]anthracene	Benz[*a*]anthracene	56-55-3	BaA
Benzo[*a*]fluorene	11 H-Benzo[*a*]fluorene	238-84-6	BaFL
Benzo[*b*]fluorene	11 H-Benzo[*b*]fluorene	243-17-4	BbFL
Benzo[*b*]fluoranthene	Benz[*e*]acephenanthrylene	205-99-2	BbFA
Benzo[*ghi*]fluoranthene	Benzo[*ghi*]fluoranthene	203-12-3	BghiF
Benzo[*j*]fluoranthene	Benzo[*j*]fluoranthene	205-82-3	BjFA
Benzo[*k*]fluoranthene	Benzo[*k*]fluoranthene	207-08-9	BkFA
Benzo[*ghi*]perylene	Benzo[*ghi*]perylene	191-24-2	BghiP
Benzo[*c*]phenanthrene	Benzo[*c*]phenanthrene	195-19-7	BcPH
Benzo[*a*]pyrene	Benzo[*a*]pyrene	50-32-8	BaP
Benzo[*e*]pyrene	Benzo[*e*]pyrene	192-91-2	BeP
Chrysene	Chrysene	218-01-9	CHR
Coronene	Coronene	191-07-1	COR
Cyclopenta[*cd*]pyrene	Cyclopenta[*cd*]pyrene	27208-37-3	CPP
Dibenz[*a*,*h*]anthracene	Dibenz[*a*,*h*]anthracene	53-70-3	DBahA
Dibenzo[*a*,*e*]pyrene	Naphtho[1,2,3,4-*def*]chrysene	192-65-4	DBaeP
Dibenzo[*a*,*h*]pyrene	Dibenzo[*b*,*def*]chrysene	189-64-0	DBahP
Dibenzo[*a*,*i*]pyrene	Benzo[*rst*]pentaphene	189-55-9	DBaiP
Dibenzo[*a*,*l*]pyrene	Dibenzo[*def*,*p*]chrysene	191-30-0	DBalP
Fluoranthene	Fluoranthene	206-44-0	FA
Fluorene	9H-Fluorene	86-73-7	FL
Indeno[1,2,3-*cd*]pyrene	Indeno[1,2,3-*cd*]-pyrene	193-39-5	IP
5-Methylchrysene	Chrysene, 5-methyl-	3697-24-3	5-MCH
1-Methylphenanthrene	Phenanthrene, 1-methyl-	932-69-9	1-MPH
Naphthalene	Naphthalene	91-20-3	NA
Perylene	Perylene	198-55-0	PE
Phenanthrene	Phenanthrene	85-01-8	PHE
Pyrene	Pyrene	129-00-0	PY
Triphenylene	Triphenylene	217-59-4	TRI

Annex III

Outline of a
Code of Practice on PAH and processing practices

Proposed *draft* Code of Practice for PAH and Reduction of such Components in Processes Used in Food Production

1. Introduction

The general purpose of the Codex Alimentarius is to protect consumers' health while ensuring fair practice in the food trade.

This paper defines a Code of Practice for food processing with the goal to optimise reduction or elimination of the PAH in the final foodstuffs. The benefits taken into account in this paper should include availability of traditional smoked food products, prevention of degradation or microbiological contamination and growth via drying, and the potential for lowering the risks to human health from the content of PAH in foods formed in processing.

2. Scope

The subject of this Code of Practice is the reduction of PAH formation in food during processing. Principal sources of oral exposure of PAH as a contaminant coming from processing being smoked or dried foods.

The Code of Practice does not cover PAH in food in relation to

a. Environmental contamination

b. Drinking water

c. Cooking in private homes or the catering sector

3. Definition[5]

Contaminant is defined as "any substance not intentionally added to food, which is present in such food as a result of the production (including operation carried out in crop husbandry, animal husbandry and veterinary medicine), manufacture, processing, preparation, treatment, packaging, transport or holding of such food or as a result of environmental contamination. The term does not include insect fragments, rodent hair and other extraneous matter."

Drinking water is water, which meets the quality standards of drinking water described in the WHO Guidelines for Drinking Water quality.

4. General conditions in food processing

4.1 A hazard analysis should be conducted for individual processes of foodstuffs or groups of foodstuffs before and after processing.

4.2 ….

5. Evaluation of compliance with relevant legislation

5.1 Processing of food shall be in compliance with relevant national or international legislation and standards.

6. Hazard analysis of processes used in food production

The food producer should carry out a hazard analysis on the intended use of processes in food production taking into account the different processes, which could be used to the production of the specific final food type.

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5 Codex Procedural Manual, Fourteenth Edition, FAO and WHO, 2004.

The hazard analysis should address the following points:

- ⇨ Potential and sources for introducing food safety hazards like PAH and the effect on consumer health
- ⇨ Feasibility and effectiveness of control under commercial conditions (cost, availability, occupational hazards)
- ⇨ Controllability

Other legitimate factors should also be considered like

- ⇨ Consumer perception
- ⇨ Effects on sensory properties and quality of the product (the ideal method would have no adverse effects on the appearance, smell, taste or nutritional properties of the food.)

6.1 Use of processes as smoking and drying

6.1.1 The different variables in the processes, like fuel, woods etc. should be assessed in relation to formation of PAH in the process.

6.1.2 The microbiological quality of the final food product should be evaluated in relation to its potential to contaminate the processed foodstuffs and the growth conditions for pathogens during processing and in the final food.

6.2 Sources of PAH in processing

6.2.1 Ways to reduce PAH when drying

6.2.2 Ways to reduce PAH when smoking, including use of Alternate Smoke processes or smoke flavours

6.3 Overall efficacy:

Use of a specific process should be justified by documentation of a need and documentation of the final foods.

6.4 Microbial aspects

The microbiological status of the foodstuff should be assessed as well as the effect of the process. The assessment should include monitoring of the microbiological quality of the foodstuff over a period of time corresponding to the duration of treatment in order to make sure that the effect is satisfactory.

6.5 Chemical aspects

6.5.1 The chemical contamination of the processed foodstuff after processing should be described in order to assess possibilities for reaction products.

6.5.2 Considerations should be made as to which process should be used and whether a less contaminating process is available.

7. Risk management and practical code of practice

Annex IV

Draft Project Document: Code of Practice on PAH and Processing Practices.

The purpose and the scope of the standard.

The scope is to develop Code of Good Manufacturing Practice for reduction of contamination of food with PAH from processing like smoking and direct drying.

Its relevance and timeliness.

JECFA ~~has~~ reviewed PAH in February 2005 (JECFA, summary report, 2005). The Committee concluded that the critical effect of PAH is carcinogenicity. As a number of PAH are also genotoxic, it is not possible to assume a threshold mechanism and a PTWI could not be established. JECFA used a margin of exposure approach to conclude that PAH are of low concern to human health. The Committee also concluded that measures to reduce intake of PAH could include avoiding contact of foods with flames, and cooking with the heat source above rather than below the food. Efforts should be made to reduce contamination with PAH during drying and smoking processes, e.g. by replacing direct smoking (with smoke developed in the smoking chamber, traditionally in smokehouses) with indirect smoking.

The main aspects to be covered.

The draft Code of Practice will cover the parameters to be controlled during processes like smoking and drying of foodstuffs (*to be decided on*). In addition, it will support the advice given by JECFA on reduction of PAH in processed foods.

An assessment against criteria for the establishment of work priorities.

This proposal is consistent with the following criteria for the establishment of work priorities: Codex Alimentarius should protect consumers by ensuring food safety and e.g., reduce exposure to PAH.

Relevance to the Codex strategic objectives.

This proposal is consistent with the strategic vision statement of the strategic Framework 2003-2007.

Information on the relation between the proposal and other existing Codex documents.

This new work is recommended in the Discussion Paper on polycyclic aromatic hydrocarbons (PAH) and food processing (CX/FAC 06/XX/YY).

Identification of any requirements for and availability of expert scientific advice.

Exposure assessment is needed based on more data from the Codex Alimentarius Member States.

Identification of any need for technical input to the standard from external bodies so that this can be planned for.

Data is needed from Codex Member States on PAH content in foodstuffs.

The proposed timeline for completion of the new work, including the start date, the proposed date for adoption at step 5, and the proposed date for adoption by the Commission; the timeframe for developing a standard should not normally exceed five years.

If the Commission approves, in 2006, that the proposal for this new work should proceed, the draft Code of Practice will be circulated for consideration at step 3 at the 39th session of CCFAC. Advanced to step 5 is planned for 2008 and additional session of the CCFAC might be necessary to finalise the revision for adoption at step 8 by the subsequent session of the CAC.