codex alimentarius commission

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WORLD HEALTH ORGANIZATION

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JOINT FAO/WHO FOOD STANDARDS PROGRAMME
CODEX COMMITTEE ON CONTAMINANTS IN FOODS
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DRAFT CODE OF PRACTICE FOR THE REDUCTION OF CONTAMINATION IN FOOD WITH POLYCYCLIC AROMATIC HYDROCARBONS (PAH) FROM SMOKING AND DIRECT DRYING PROCESSES (N07-2006)

Comments at Step 6 in response to Circular Letter (CL2008/24-CF) submitted by Brazil, Japan, Kenya, Philippines, Thailand and the United States of America

BRAZIL

INTRODUCTION

1. Many chemical contaminants are formed during the combustion of fuel both in the smoking and in the direct drying processes. Examples include polycyclic aromatic hydrocarbons (PAH), dioxins, formaldehyde, nitrogen and sulfur oxides (relevant for formation of e.g. nitrosamines). Furthermore, heavy metals are also found in combustion gases. The types and amount depend on the fuel used, the temperature and possible other parameters (Nielsen and Illerup, 2003).

2. This Code of Practice covers contamination of food with PAH from smoking and direct drying, only. ~~PAH are chemical contaminants, which can be found in food~~.

A list of PAH included in the Joint FAO/WHO Expert Committee on Food Additives (JECFA) risk assessment of PAH in 2005 (WHO 2006) is found in **Annex I**.

3. Hundreds of individual PAH may be formed and released as a result of incomplete combustion or pyrolysis of organic matter, during forest fires and volcanic eruptions as well as industrial processes or other human activities, including the processing and preparation of food and the carbonization of wood and other plant materials to make charcoal (WHO, 2006) (from 19- definitions)). Owing to their mode of formation, PAHs are ubiquitous in the environment and therefore enter to the food chain, especially via air and soil (Ciecierska & Obiedzinski, 2007). These contaminants are widespread in foodstuffs not only as a result of the environmental pollution but also as a consequence of some thermal treatments, which are used in the preparation of foods. Commercial and domestic food preparation ~~Processing procedures~~ such as ~~as~~ smoking, drying, roasting, baking, barbecuing or frying are recognized as an important source of food contamination.

~~Sources of PAH are contamination during food processing or the environment~~. ~~PAH may be formed during food processing in both commercial and domestic food preparation, notably:~~

~~• Smoking,~~

~~• Drying,~~

~~• Cooking (roasting, baking, frying and barbecuing).~~

Furthermore PAHs can be present in the raw materials due to environmental contamination from the air or uptake by plants from contaminated soils. Presence of PAH in e.g. vegetable oils can also originate from smoking and drying processes used to dry oil seeds prior to oil extraction.

4. Traditional processes such as smoking and direct drying provide a wide variety of food textures and flavours and consequently a broader choice for consumers. Many types of smoked and dried foods are traditional food items, where these types of processes have been used to prolong storage times and quality and provide flavour and consistency required by consumers. The extension of shelf life may also have an effect on the nutritional value of foodstuffs, such as preservation of the vitamin content. (from 32).

SCOPE

11. The scope of this Code of Practice is PAH contamination during commercial smoking, both direct and indirect, and direct drying processes. As indirect drying is not regarded as a significant source of PAH, it is not covered by the Code of Practice and will not be addressed in this Code of Practice (from 16).

13. This Code of Practice covers contamination with PAH only. It should, however, 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 food products. The possible interplay among levels of contaminants like PAH, heterocyclic amines, and nitrosamines is not always well understood, but these contaminants can be food safety problems either as such or due to the reaction with food components. This is the case of ~~e.g.~~ nitrogen oxide reaction with components in the food leading to the formation of nitrosamines. It should be underlined that any guidance given to reduce ~~minimize~~ PAH levels in a final product should not lead to increased levels of other chemical contaminants from smoke and/or a reduced microbiological safety ~~in other contaminants.~~

DEFINITIONS

16. *Drying, indirect* is a drying process where the combustion gas is not coming into direct contact with the foods, where the drying gas is heated via a heat exchanger, electricity or by other means. ~~As indirect drying is not regarded as a significant source of PAH, it is not covered by the Code of Practice and will not be addressed in this Code of Practice~~ (moved to11).

19. *Polycyclic aromatic hydrocarbons (PAH)* are a group of contaminants that 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 forest fires and volcanic eruptions as well as industrial processes or other human activities, including the processing and preparation of food and the carbonization of wood and other plant materials to make charcoal (WHO, 2006).~~ (It is not a definition. We suggest move to paragraph 3).

20. *Pyrolysis* is the chemical decomposition of organic materials by heating in the absence of oxygen or any other reagents, except possibly steam (http://en.wikipedia.org/wiki/Main_Page). We suggest the following definition: "Pyrolisis is the breakdown of substances at high temperature and in absence of oxygen" (Omaye, 2004).

21. *Smoke* consists of liquid and solid particulates suspended in a gaseous phase. Particles in the smoke, generally of a size of 0.2-0.4 µm (or as low as 0.05 to 1 µm (Guillén *et al.*, 2000)), are estimated to constitute 90% of its overall weight. ~~The chemical composition of smoke is complex and more than 300 components have been identified (Möhler, K, 1978; Solttes and Elder, 1981; Simko, P, 2005). (moved to annex III).~~

23. *Smoking, direct* is the traditional type of smoking process, where the smoke is developed in the chamber in which the food is processed. ~~Direct smoking requires less equipment than indirect smoking but can result in higher levels of PAH in the final food product~~ (moved to 45, because it is not a definition). We suggest the following definition "Direct smoking is the conventional (traditional) type if smoking process where the smoke is generated in the same chamber as the product is processed" (New Zealand Food Safety Authority, 2007).

24. *Smoking indirect* is a process where smoke generators are used, and the smoke is being developed in a chamber, separate from where the food is smoked. The smoke is possibly cleaned in various ways e.g. by use of a water filter or a tar condenser before being fed into the smoke chamber. We suggest the following

definition: Indirect smoking is the smoking process using smoke generators which generate smoke in a separate chamber, the smoke may be cleaned by various methods before being fed into the smoking chamber (New Zealand Food Safety Authority, 2007).

25. ~~*Wood* is a solid material derived from woody plants, notably trees but also shrubs. Wood from the latter is only produced in small sizes, reducing the diversity of uses. In its most common meaning, "wood" is the secondary xylem of a woody plant, but this is an approximation only: in the wider sense, wood may refer to other materials and tissues with comparable properties (http://en.wikipedia.org/wiki/Main_Page). Wood consists of three main components: cellulose, hemicellulose and lignin (Andersen and Rissum, 1994) in a 2:1:1 ratio, and represent 95% of dry matter. *Wood* is often divided into two groups: Hardwood and softwood. Generally, there is more hemicellulose in hardwoods than in softwoods and more lignin in conifers, which are covered by the group of softwoods. On average, hardwood is of higher density and hardness than softwood.~~, ~~but there is considerable variation in actual wood hardness in both groups, with a large amount of overlap; some hardwoods (e.g. balsa) are softer than most softwood, while yew is an example of hard softwood. The dominant feature separating hardwoods from softwoods is the presence of pores, or vessels. Hardwood species are more varied than softwood. There are about a hundred times as many hardwood species as softwoods. The vessels may show considerable variation in size, shape of perforation plates (simple, scalariform, reticulate, foraminate), and structure of cell wall (e.g. spiral thickenings)~~ (~~http://en.wikipedia.org/wiki/Hardwood~~ It is not necessary definitions of wood, softwood and hardwood. We suggest move the text above to item b of Annex III. We would rather to mention the characteristics of the wood to use in the smoking and drying processes.

26. ~~*Wood, hardwood* is a term designating wood from broad-leaved (mostly deciduous, but not necessarily, in the case of tropical trees) or angiosperm trees. Hardwoods have broad leaves and enclosed nuts or seeds such as acorns. They often grow in subtropical regions like Africa and also in Europe and other regions such as Asia (http://en.wikipedia.org/wiki/Hardwood).~~

~~27. *Wood, softwood* is a term used for wood from conifer trees.~~

PREVENTIVE MEASURES AND GENERAL CONDITIONS IN GOOD MANUFACTURING PROCESSING OF FOOD. **WE SUGGEST CHANGE FOR THE FOLLOWING THE TITLE:**

IMPORTANT FACTORS AFFECTING THE PAH CONTENT IN SMOKED FOODS.

28. The food producer should be aware of the conditions under which higher levels of PAHs are generated and wherever possible, should manage those conditions to minimize their formation. ~~The food producer~~ To accomplish this, it should be carried out an analysis of important points to consider in processes used or intended to be used in food production.

30. Other factors may also legitimately be considered, such as

⇨ Microbiological status of the product

⇨ Effects of the processes on organoleptic properties and quality of the product (the ideal method would have no adverse effects on the appearance, ~~odour~~ flavour, taste or nutritional properties of the product)

~~⇨ Compliance with relevant legislation and relevant code of practices~~. It is already mentioned in the paragraph 31.

~~**EVALUATION OF COMPLIANCE WITH RELEVANT LEGISLATION**~~

~~31. Processed food shall be in compliance with relevant national or international legislation and standards, including general requirements for consumer protection. Furthermore, food shall be produced in accordance with relevant Codex or national codes of practice. Some of these may contain further information about drying or smoking, which should also be considered.~~

GENERAL REMARKS ON SMOKING AND DRYING PROCESSES

32. ~~Traditional processes such as smoking and direct drying provide a wide variety of food textures and flavours and consequently a broader choice for consumers. Many types of smoked and dried foods are traditional food items, where these types of processes have been used to prolong storage times and quality and provide flavour and consistency required by consumers. The extension of shelf life may also have an~~

~~effect on the nutritional value of foodstuffs, such as preservation of the vitamin content. (~~moved to paragraph 4)

33. The formation of PAH during smoking and drying are dependent on a number of variables, including

a. Fuel (woods and other plant materials, diesel, gases, liquid/solid waste and other fuels)

b. Cooking method (smoking or drying - direct or indirect)

c. Smoke generation process in relation with the temperature of pyrolysis and with the airflow in case of smoke generator (friction, smouldering, auto-combustion, thermostated plates) or in relation with other methods such as regenerated smoke (liquid smoke vaporisation and direct smoking).

~~d. The distance between the food and the heat source~~

d. The distance and the position of the food in relation to the heat source

e. Fat content of the food and what happens to it during processing

f. Duration of processing

g. Temperature during processing

h. Cleanliness and maintenance of equipment

i. Design of the smoking chamber and the equipment used for smoke/air mixture (which influence the smoke density on the smoking chamber).

34. In general, changes in processing techniques can in some cases reduce the amount of PAH formed during processing and found in the processed food. Alteration of the process could be done in different ways after evaluation of the important points for consideration.. Examples are the use of ~~e.g. by using~~ indirect drying or smoking processes instead of direct drying or smoking; ~~via the~~ selection of fuel for drying or of wood species and other plant materials used in the smoking process; and ~~by~~ adjusting times and processing temperatures.

PREVENTIVE MEASURES AND GENERAL CONDITIONS IN GOOD MANUFACTURING SMOKED FOODS

~~SMOKING PROCESS~~

Smoking techniques have been used for centuries as a method for preserving meat and fish. Smoking impregnates the high-protein food with aromatic components which lend flavour and colour to the food, and also play a bacteriostatic and antioxidant role (Hattula et allii, 2001).

36. Foodstuffs such as meat and fish, some types of cheese have been smoked in many countries for centuries. Originally the purpose was to preserve the food, partly by reducing the moisture content and partly through the transfer of anti-microbial and antioxidant components such as phenolic compounds from the smoke to the food. The composition of the smoke depending of e.g. the type of wood or other plant materials, the amount of oxygen present and the temperature of pyrolysis and possibly the length of time for which the plant materials are burned (from 58).

Fuel used in processing

39. For some foods, the effect of fuel choice on taste may be the important point to consider in choosing a fuel. In any event, fuels like e.g. diesel, rubber (e.g. tires) or waste oil should not be used even as a partial component, as they may well lead to increased PAH levels.. The use of other fuels than wood and other plant materials for the purpose of smoking foodstuffs should be discouraged.

(from Annex III) Woods treated with chemicals for preserving, waterproofing, fireproofing etc. should not be used. Such treatments may result in tainting of the food as well as the introduction of other contaminants e.g. dioxin from woods treated with pentachloro phenol (PCP) (Hansen and Hansen, 2003). The woods used for smoking and the woods used for the production of primary products (liquid smokes) shall not have been treated, intentionally or not, with chemical substances during the last six months immediately before felling or after felling, unless it can be demonstrated that the compound used for this treatment does not produce potentially toxic substances during burning.

Processing

It is generally recognized four main types of smoking process very dependent of

the technique for generating wood smoke: smouldering, thermostated plates, friction and in recent decades, liquid smoke vaporisation has been used. Smouldering, thermostated plates and friction processes allow smoke to be produced by pyrolysis of wood sawdust, wood chips and wood log, respectively.. Liquid smoke (smoke flavoring) consists in the atomization (vaporisation) of liquid smoke obtained from condensation of wood smoke (Varlet et allii, 2007). With the liquid smoke system, no build-up of tars in the smoking chambers occurs (Hattula et allii, 2001). Smoking chambers with external smoke generators, and emission and temperature control systems, have replaced direct flue gas smoking which used more traditional kilns (Hattula et allii, 2001).

44. Smoke is produced by pyrolysis of the fuel at temperatures of around 300-450 °C (and up to 600 °C) in the glow zone. Pyrolysis is the destruction of wood or other plant materials by a heating process. Activation energy provided by electricity allows wood to vaporize into combustible gas, which mix with the combustive agent (air). To avoid flames, airflow needs to be adjusted and controlled in order to prevent going beyond the temperature of inflammation of wood or other plant materials. In this meaning, it is an incomplete combustion, which leads to PAH production (move to Annex III).

45. Differences in the smoking processes can lead to highly variable PAH levels in the final food product (European Commission, 2002). Direct smoking requires less equipment than indirect smoking but can result in higher levels of PAH in the final food product (from 23). ~~The choice of technology for processing is very important for the final concentration of PAH. The different variables in the processes used should be identification of important points to consider e.g. of the parameters critical for potential formation of PAH in a specific process used.~~

~~46.~~ 47. The traditional smoking processes are often divided into three groups after the temperatures used in the smoke chamber during processes:

a. *Cold* smoking with temperature 18-25 °C. Used for e.g. some fish species and salami-type sausages

b. *Semi-warm* with temperatures from 30- 40 °C. Used for e.g. some fish species, bacon and pork loin

c. *Warm* smoking is smoking combined with heating resulting in a temperature of 70-90 °C. Used for e.g. some fish species, and frankfurter type sausages.

Temperature is of importance for the partial/incomplete combustion of the fuel. The composition of the smoke depends on the temperature, which should be adjusted to minimize PAH formation. However, more data is needed to document which temperatures would be recommendable (from 51).

~~47~~. 46. Replacing direct smoking with indirect smoking can significantly reduce contamination of smoked foods. In modern industrial kilns, an external smoke generator can be operated automatically under controlled conditions, to wash the smoke from particles before coming in contact with the food ~~to clean the smoke~~ and to regulate its flow as it is brought into contact with the food. For more traditional or smaller scale operations, this may not, however, be an option.

48. Selecting appropriate smoking chamber and device for treatment of air/smoke mixture affect the concentration of PAH in the final product (from 60.d.). The type of generator used should be based on an assessment of possible reduction of the PAH content in the final food and where possible include washing of the smoke after the generator and before the smoke chamber. Good results are achieved by installing baffles after the smoke generator equipped with a device for decantation of tar. A more efficient way is to manage the pyrolysis temperature and decanting of heavy phase tanks to a cooling device with baffles. The scientific background and data to illustrate the exact influence of the use of different types of fuel, time, temperature etc. is limited and specific testing is needed in the identification of important points to consider in the individual processes. Also other methods like use of long pipes in the equipment can reduce the PAH.

50. Oxygen needs to be adequate to ensure partial/incomplete combustion of the fuel. Too much oxygen may raise the temperature in the glow zone and lead to increased formation of PAH. A lack of oxygen may lead to the formation of more PAH in the smoke, as well as producing carbon monoxide, which may be hazardous to operators. It is recommended to adjust the airflow to avoid too high temperature in the glowing zone during smoke generation (from 60.c.)

51. Temperature is of importance for the partial/incomplete combustion of the fuel. The composition of the smoke depends on the temperature, which should be adjusted to minimize PAH formation. However, more data is needed to document which temperatures would be recommendable (from former 46).

52. In principle, the smoking time should be as short as possible to minimize the exposure of the food surfaces to PAH-bearing smoke. However, in the case of hot smoking, when the product is being cooked at the same time, it will be essential to allow sufficient time for the product to be cooked thoroughly. In case hot smoke is the only heat source (traditional smoke houses), the smoking chamber should be heated before the food products are placed into the smoking chamber. Dependency of time in the smoking and charcoal grilling processes is illustrated by data obtained by Chen and Lin in 1997. Smoking time is not an important parameter as long as the source for smoke is well managed. Moreover, short smoking times may have an impact on food safety and shelf life. Reducing the time that food is in contact with smoke, this should take the consequences for microbiological safety and quality into consideration (from 60 f e g). Clearly preventative measures cannot be taken in isolation from other considerations and it is vital that they do not adversely impact on the sensory properties and consumer acceptance of the product. Additionally, microbiological stability and nutritional properties need to remain unimpaired and care needs to be taken to ensure that other contaminants are not inadvertently introduced.

~~**Post smoking treatment**~~

53. There are two types of cleaning steps to be used either during processing or as post process treatment:

a. During the process smoke may be washed ~~The cleaning of smoke~~ before it enters the smoking chamber. This can be achieved by washing (scrubbing), using a tar condenser, cooling or filtering. All measures to remove particle-bound PAH from the smoke

b. Pos smoking treatment involves ~~T~~the cleaning of the smoked product itself. In this case rinsing the product or immersing it into water may remove soot and particles containing PAH on the surface of the food. This type of cleaning would not be possible to use for all types of products, e.g. not for smoked fish and fishery products.

55. However, washing of the product should not be used for fishery products as it could result in lower organoleptic quality and increased microbiological risk. Fish products are often smoked as the whole fish with the skin, and if the skin is not eaten, part of the PAH contamination are removed together with the skin.

The recommendation could be to prioritise smoking of fish with the skin on and, eventually, removing the skin before consumption.

~~**IMPORTANT POINTS TO CONSIDER AND RECOMMENDATIONS FOR PRODUCTION OF SMOKED FOOD** (Todo o texto refere-se a repetições das considerações anteriores. Sugestão: retirar o titulo e seu conteúdo. As poucas frases inéditas foram removidas e colocadas em pontos mais significativos do draft)~~

~~56. PAH content of smoked foods can be minimised by identifying the important points to consider mentioned below. An HACCP system might be applied~~

~~57. Fuel:~~

~~a. The type and composition of wood used to smoke foods, including age of and water content in the wood used. (ja foi mencionado)~~

~~b. When individual species of woods and other types of fuels like bagasse (from sugarcane), corn cob and coconut husk and shell are use, the use should be evaluated in light of PAH contamination (já comentado).~~

~~c. Do not use woods treated with chemicals (já comentado)~~

~~d. The use of other fuels: Avoiding the use of fuels as diesel fuel, waste products, especially rubber tyres, olive residues and waste oil which may already contain significant levels of PAH)~~

~~e. Particle sizes (saw dust, wood shavings etc.) (já foi ditto)~~

~~f. Influence on the taste of the final food (já foi dito).~~

~~58. Smoke developed and used in the process:~~

~~a. The composition of the smoke depending of e.g. the type of wood or other plant materials, the amount of oxygen present and the temperature of pyrolysis and possibly the length of time for which the plant materials are burned (sugestão de ir para 37).~~

~~b. The design of the smoking chamber and of the equipment used for smoke/air mixture~~

~~c. Filtering or cooling the smoke where possible (já foi dito).~~

~~d. Install baffles after the smoke generator equipped with a device for decantation of tar if possible (já foi dito).~~

~~59. Foodstuffs smoked:~~

~~a. The position of the food in the smoke chamber and the distance between the food and the heat source (já foi ditto)~~

~~b. Chemical properties and composition of food, e.g. the fat content of the food to be smoked (já foi dito)~~

~~c. Deposits of smoke particles on the surface and the suitability of the surface for human consumption.(são apenas citações do que já foi explicado)~~

~~For fish, the recommendation could be to prioritise smoking of fish with the skin on~~

~~d. The microbiological quality after processing .(são apenas citações do que já foi explicado)~~

~~e. The organoleptic properties of the final food. .(são apenas citações do que já foi explicado)~~

~~60. Smoking process:~~

~~a. Whether the smoking process is a direct or indirect process (sem sentido)~~

~~b. Prior assessment of smoke generators by taking account of the resulting PAH content in the smoke (sem sentido)~~

~~c. Adjusting of the airflow to avoid too high temperature in the glowing zone during smoke generation (sugestão de ir para item 50)~~

~~d. Selecting appropriate smoking chamber and device for treatment of air/smoke mixture (sugestão de ir para item 48)~~

~~e. The accessibility of oxygen during the smoking process (sem sentido)~~

~~f. Smoking time: Reducing the time that food is in contact with smoke, this should take the consequences for microbiological safety and quality into consideration (sugestão de ir para o 52)~~

~~g. Reducing the residence time of vapours in the reactor (retirar)~~

~~h. Temperatures: Temperature in the glow zone (in the smoke generation step) and temperature of the smoke in the smoking chamber (já foi ditto acima)~~

~~i. In order to avoid an increase in the PAH content through fat dripping into the open fire, perforated metal sheets can be installed between the food to be smoked and the fire (já consta no item 41).~~

~~j. Filtering of smoke or the use of a tar condenser (já foi dito)~~

~~k. The cleaning method and schedule applied in the processing unit.(já foi dito)~~

~~61. Post smoking processes:~~

~~a. The cleaning of the smoked product itself. In this case soot and particles containing PAH on the surface of the food may be removed by rinsing the product or immersing it into water (já consta do 55)~~

~~b. Washing/water cooling might lower organoleptic quality and increased the microbiological safety risk. (já consta no item 55)~~

CONSIDERATIONS IN DEVELOPING PREVENTATIVE MEASURES TO REDUCE THE PAH CONTENT OF DRIED FOODS

This section is divided in direct drying using a) sun, b) other fuels.

Sun drying

66. When drying by use of the heat from the sun, the potential source of PAH is the environment as a contamination from soil/dust or/and from combustion from industry and traffic as well as forest fires and volcanic eruptions.

Sun-drying has the advantage of using free energy from the sun. However, the benefits of greater control over the drying environment and drying time, quicker drying and less contamination from dirt, grass and insect particles, coupled with a consumer demand for a cleaner and less contaminated product may make artificial drying (dehydration) more attractive to the grower in the near future.

A major disadvantage of sun-drying is its openness to the environment. There are two components: exposure to undesirable weather conditions, and to contamination agents. Prevailing weather conditions, over which the grower has no control, greatly affect the drying rate. Contamination of dried foods with foreign matter is a serious concern to the industry. Sun-dried foods are exposed to contamination by windblown dust, seeds and pollution. It is also vulnerable to contamination by insects, and rodent and bird droppings.

67. Sun drying of crops should not take place near industrial point sources of combustion of gas, such as roads with heavy traffic, incinerators, coal-fired power stations, cement works etc., or in the immediate proximity of roads with intense traffic. Contamination from drying in such place is expected to be a special problem for foodstuff with a big surface area like, spices. However, covered dryers may protect crops from industrial sources to some extent.

Direct drying processes, other than sun drying.

The drying process should begin as soon as possible after the receipt of the crops to avoid unnecessary deterioration.

Fuel used

68. Drying in the sun is used in many countries, and besides this different types of fuel are used, e.g. natural gas, peat and mineral oils. Furthermore fuel like woods, rubber, and solid waste might be used in drying processes.

69. For some foods, the effect of fuel choice on taste may be the important points to consider in choosing

a fuel. In any event, fuels like e.g. diesel, rubber e.g. tires or waste oil should generally not be used even as a partial component, as they may well lead to increased PAH levels. Some background information on the drying process and the fuel used is given in Annex III.

Combustion gasses

70. Drying with combustion gases increased the contamination by 3- to 10-fold; use of coke as fuel resulted in much less contamination than use of oil (Bolling, 1964). Direct contact of oil seeds or cereals with combustion products during drying processes has been found to result in the formation of PAHs and should therefore be avoided, and JECFA recommend that contact of food with combustion gasses be minimized (WHO, 2006).

Foodstuffs dried

71. Many types of food like meat, many fruits like apples, pears, bananas, mangos, papaya, and apricot are usually dried. Drying is also the normal means of preservation for cereal grains such as wheat, maize, oats, barley, rice, millet and rye.

72. Contamination of vegetable oils (including olive residue oils) with PAH usually occurs during technological processes like direct fire drying, where combustion products may come into contact with the oil seeds or oil (Speer *et al.*, 1990; Standing Committee on Foodstuffs, 2001). 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. For more data, see also **Annex III**

Direct drying process

Dehydrators are useful for larger drying yards and growers. Dehydration allows a steady production cycle to be maintained, reduces labour costs and is an insurance against unfavorable weather conditions for sun

drying. A system using a combination of initial sun drying followed by finish dehydration can have considerable advantages without loss of food quality.

73. Common direct drying/heating operations and applications include drying to remove water (and/or other solvents/chemicals) added, left or produced during processing. During direct drying, hot air is blown directly into the foodstuffs and combustion products can therefore directly enter the food. One example of PAH contamination from direct drying in contamination of vegetable oils (including olive residue oils) in which oil has been contaminated with PAH during technological processes (Antonopoulos, K *et al*., 2006; Menichini, S. *et al*., 1991). Another example can be drying oil seeds prior to oil extraction.

74. Continuous flow drying, where cereals pass the drying area continuously, is a widespread grain drying method. This technique can be used for drying cereals for food. Direct heating is mainly used with temperatures up to 120 ºC for feeds. For foods, indirect heating (external heat generation) and temperatures between 65 and 80 ºC are mainly used (bread, malt etc.). The time span for both types of drying is between ½ and 1 hour, depending on the initial moisture content of the grain.

Dehydration provides a form of insurance against poor weather conditions that can handicap traditional sun- and shade-drying. Accurate control of the drying conditions (temperature, relative humidity and air movement) essential for efficient dehydration is achieved. Many kinds of fresh fruits, vegetables, herbs, meat, and fish can be dried.

IMPORTANT POINTS TO CONSIDER AND RECOMMENDATIONS ON DIRECT DRYING, EXCEPT SUN DRYING

82. Fuel used in the process:

a. The type and composition of fuel used to dry foods.

b. If woods are used, use hard wood rather than softwood, ~~and~~ do not use resinous woods or woods treated with chemicals. The low humidity of the wood is also important.

c. The use of other fuels: Avoiding the use of fuels as diesel fuel, waste products, especially rubber tires, olive residues and waste oil which may already contain significant levels of PAH

d. Operator should be aware on the influence of fuel on the taste of the final food.

83. Combustion gases developed and used in the process:

a. Contact of food with combustion gasses should be minimized

Additional references

Ciecierska, M. & Obiedzinski, M. Influence of smoking process on the polycyclic aromatic hydrocarbon's content in meat products. Acta Sci. Pol. Technol. Aliment. 6(4), 17-20, 2007.

New Zealand Food Safety Authority. Draft Meat Code of Practice. Part X. Chapter X. Smoking. September, 2007).

Omaye, S. Polyciclic aromatic hydrocarbons and Other Processng Products, p. 273-283. In. Omaye, S.(Ed.) Food and nutritional Toxicology. CRC Press, New York, NY. USA., 319 p., 2004.

Hattula, T.,Elfving, K., Mroueh, U.M. and Luoma, T. Use of Liquid Smoke Flavouring as an Alternative to Traditional Flue Gas Smoking of Rainbow Trout Fillets (*Oncorhynchus mykiss*). Lebensm.-Wiss. u.-Technol., 34, 521-525, 2001.

Varlet, V., Serot,T., Knockaert, C., Cornet, J., Cardinal, M., Monteau, F., Le Bizec, B. and Prost,C. Organoleptic characterization and PAH content of salmon (*Salmo salar*) fillets smoked according to four industrial smoking techniques. J Sci Food Agric 87:847–854 (2007).

Annex III

PAH CONTENT IN SOME SMOKED AND DRIED FOODS

The Annex gives background information on formation and content of PAH is some foodstuffs.

Formation of PAH from fuel used for smoked of food.

a. . The chemical composition of smoke is complex and more than 300 components have been identified (Möhler, K, 1978; Solttes and Elder, 1981; Simko, P, 2005). The main groups of chemicals in the smoke are phenolic and carbonylic compounds, acids, PAH and nitrogen oxides and their reaction products. Some examples of components found to be contributing to the smoke flavour are: phenolic compounds, carbonylated phenolic compounds, derivatives, including cyclopentenone, cresols/alkylated phenolic compounds (of guaiacol type) (Selttes, E.J., Elder, T. J. 1981), phenolaldehydes, pentenone, and alcylphenols of the guajacol type (Selttes, E.J and Elder, T.J., 1981).

b. Wood consists of three main components: cellulose, hemicellulose and lignin (Andersen and Rissum, 1994) in a 2:1:1 ratio, and represent 95% of dry matter. *Wood* is often divided into two groups: Hardwood and softwood. Generally, there is more hemicellulose in hardwoods than in softwoods and more lignin in conifers, which are covered by the group of softwoods. On average, hardwood is of higher density and hardness than softwood, but there is considerable variation in actual wood hardness in both groups, with a large amount of overlap; some hardwoods (e.g. balsa) are softer than most softwood, while yew is an example of hard softwood. The dominant feature separating hardwoods from softwoods is the presence of pores, or vessels. Hardwood species are more varied than softwood. There are about a hundred times as many hardwood species as softwoods. The vessels may show considerable variation in size, shape of perforation plates (simple, scalariform, reticulate, foraminate), and structure of cell wall (e.g. spiral thickenings) (http://en.wikipedia.org/wiki/Hardwood) (from 25). PAH are formed in wood smoke by two main routes: either by HACA (hydrogen abstraction/acetylene addition), i.e. by consecutive additions of an acetylenic motif), or by thermodegradation of lignin. Smoke is produced by pyrolysis of the fuel at temperatures of around 300-450 °C (and up to 600 °C) in the glow zone. Pyrolysis is the destruction of wood or other plant materials by a heating process. Activation energy provided by electricity allows wood to vaporize into combustible gas, which mix with the combustive agent (air). To avoid flames, airflow needs to be adjusted and controlled in order to prevent going beyond the temperature of inflammation of wood or other plant materials. In this meaning, it is an incomplete combustion, which leads to PAH production (from 44). During pyrolysis, thermodegradation breaks down furan and pyran heterocycles in lignin, producing a large diversity of volatile compounds while more stable aromatic cores only loose some side groups. This explains why the use of conifer woods, with their higher lignin content and the possibility of a higher contamination of PAH should be avoided.

JAPAN

General Comments

The committee agreed with the basic concept and principles of the Code of Practice through the extensive discussion at the last session of CCCF and the Code was greatly improved by the initiative of Denmark. However, there are still several issues to be clarified with a view to making the Code user-friendly and easier to follow. In addition, we would like to propose some minor modifications in order to ensure consistency and better organization of information in the Code.

We would like to provide our proposal throughout the draft Code in the attachment to this comment paper and explain the rationale for major proposals below as specific comments.

Specific Comments

Para. 8.

In order to describe different contribution of foodstuffs in the total PAH intake in each country or region, it is useful to include the summary of the 64th JECFA monograph (WHO Food Additives Series No. 55, 2006.) as general explanation. In the last session, the Committee noted that inclusion of scientific references such as names of persons, specific regional/national legislations and other sources of information in the final Codex texts should be avoided as much as possible as scientific facts would become outdated. We propose to replace para.8 with the following explanation extracted from the monograph of the 64th JECFA.

8. The major contributors to intakes of PAH were cereals and cereal products (owing to high consumption in the diets of many countries) and vegetable fats and oils (owing to higher concentrations of PAH in this food group). Generally, despite their usually higher concentration of PAH, smoked fish and meats and barbecued foods don't contribute significantly, particularly they

are small component of the diet. However they do make larger contributions leading to higher PAH intakes where these foods make up a large part of the diet.

Paras 9-10.

The objective of this Code of Practice is to prevent and reduce PAH contamination of foods rather than to identify important points to consider. In addition, it needs to be mentioned clearly who are target users of the Code. Therefore, we propose to modify the objective section as follows:

9. This Code of Practice intends to provide guidance for national authorities and manufacturers to prevent and reduce contamination of food with PAH in commercial smoking and direct drying processes. For this purpose, ~~The objective of~~ this Code of Practice ~~is to identify~~ identifies important points to consider and provides relevant recommendations~~for a reduction of contamination of food with PAH during smoking and direct drying processes~~. The smoking and direct drying processes are used both in industry and in private households. Consumers might smoke food ~~and would~~ often ~~use a~~ directly ~~process~~, while drying can be done either directly or indirectly, e.g. in the sun or in a microwave oven. The Code of Practice and the guidance given is mainly directed to the industry, but could be used as the basis for information to consumers.

10. ~~The Code of Practice is intended to provide tools to optimise smoking and drying processes in order to reduce PAH in the final foodstuffs.~~ The Code of Practice must recognise the benefits of smoking and drying including the availability of traditional smoked food products, prevention of spoilage and microbiological contamination and growth, and the potential for lowering the risks to human health from PAH formed in foods during processing.

Paras 11-13.

The scope includes several different parameters: However, due to the complexity of the text, it is not clear to users of the Code what are within the scope and what are not. For instance, para.12 d. describes that the Code does not cover PAH contamination originating from "environmental contamination", on the other hand, para.78 refers to prevention measures for contamination from sources of industries or traffic (i.e. environmental contamination). Therefore we would like to propose to modify the scope section as follows to improve clarity and user-friendliness of the Code.

11. The scope of this Code of Practice is PAH contamination during commercial smoking, both direct and indirect, and direct drying processes. PAH contamination from indirect drying and cooking (e.g. roasting, baking, frying, barbecuing, etc.) are out of the scope. All other food processing including smoking and drying in private homes are not covered by this Code, either.

12. The Code of Practice does not cover PAH contamination in final food product originating from use of raw material contaminated from the environment (e.g. air, soil, water, etc.). In addition, this Code of Practice does not consider a potential influence from use of herbs and spices in the smoking process[1].

~~a. Use of herbs and spices in the smoking process~~ ~~[1]~~ ~~;~~

~~b. Indirect drying;~~

~~c. Other food processes, including barbecuing and other types of cooking in private homes or the catering sector; and~~

~~d. Environmental contamination.~~

13. This Code of Practice covers contamination with PAH only. It should, however, 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 safety~~standard~~ of the food products. The possible interplay among levels of contaminants like PAH, heterocyclic amines, and nitrosamines is not always well understood, but these contaminants can be food safety problems either as such or

[1] In the traditional smoking process, the fuel used is often various wood species, in some cases with herbs and spices, e.g. juniper berries, to give a characteristic flavour. Such herbs and spices may be a potential source for PAH contamination. However, many different types of herbs and spices can be used, but normally only in smaller quantities and knowledge about the influence of using herbs and spices is limited. Their use is therefore not considered in this Code of Practice.

due to the reaction of e.g. nitrogen oxide with components in the food leading to the formation of nitrosamines. It should be underlined that any guidance given to minimize PAH should not lead to ~~increase~~ increased risk to human health ~~in other contaminants~~.

Paras 15-17.

The definitions must be clear and consistent with the scope. We understand that sun drying is covered by the Code. On the other hand, in some foods dried in natural condition without artificial heating, drying processes are not always conducted under the direct "sunshine". There are some cases where the food is dried with natural air such as wind in the shade or under the roof open but to the environment. It is not clear whether those foods dried under such conditions are covered in this Code. For this reason, we propose to modify paras 15 and 16, and to make a new paragraph for a new definition of ***"Sun drying"***. Or else, other suitable term should be used.

15. *Drying, direct* are refers to two types of drying process: One is a drying process where the combustion gas is used directly as the drying gas in contact with the foods~~.~~; and the other is sun drying.~~The direct drying process can be drying in the sun or by using combustion gases.~~

15bis. *Sun drying* is a direct drying process where natural sources including sunshine, wind, air, etc. are used for drying under circumstances open to the environment.

16. *Drying, indirect* is a drying process where the combustion gas~~es~~ do~~is~~ not come~~coming~~ into direct contact with the foods, where the hot air~~drying gas~~ is heated via a heat exchanger, electricity or by other means. As indirect drying is not regarded as a significant source of PAH, it is not covered by the Code of Practice ~~and will not be addressed in this Code of Practice~~.

Paras 28-30.

We propose to modify the title of the section starting from para. 28 and the paragraphs in the section as follows, taking into consideration the objective of the section.

~~**PREVENTIVE MEASURES AND GENERAL CONDITIONS IN GOOD MANUFACTURING PROCESSING OF FOOD.**~~

GENERAL PRINCIPLES FOR REDUCING PAH CONTAMINATION IN FOOD

28. The food producer should carry out an analysis of important points to consider in processes used or intended to be used in food production with smoking or direct drying.

28bis. The first step of the analysis is to identify important points to consider. Possible major important points to consider are described later in the Code .

29 The producer should evaluate the identified important points to consider including ~~I~~information on PAH and conditions in the process leading to presence of PAH of significance for food safety ~~should be considered~~. The information to be considered would be on:

- **Possible sources of ~~contaminants such as~~ PAH during the process;**
- **Possible effects on consumer health;**
- **Controllability; and**
- **Possible measures to reduce PAH contamination.~~Feasibility and effectiveness of controls (cost, commercial availability, occupational hazards)~~**

~~**In the Code of Practice for the smoking and drying process, important points to consider are highlighted in the flow sheets in Annex IV.**~~

30 ~~Other factors may also legitimately be considered,~~ The producer should take appropriate measures to control the identified important points for reducing PAH, based on the results of the analysis and other legitimate factors relevant for human health protection and economic activities such as

- **Possibility to pose or increase other risks including ~~M~~microbiological status, and other contaminants levels of the product;**

- ⇨ **Effects of the processes on organoleptic properties and quality of the final product (the ideal method would have no adverse effects on the appearance, odour, taste or nutritional properties of the product); and**
- ⇨ **Feasiblity and effectiveness of controls (cost, commercial availability, occupational hazards).**
- ⇨ ~~**Compliance with relevant legislation and relevant code of practices.**~~

30bis. The producer should monitor the effects of the implemented measures and should review them if necessary.

Para. 53.

We propose another option for reduction of PAH contamination in post smoking treatment. A new subparagraph may be inserted into this paragraph as follows:

53. c. The shaving off the surface of the smoked roduct itsef. In case of solid smoked food e.g. smoked-dried bonito (i.e. *katsuobushi*, traditional Japanese food)), this can reduce PAH in the final product.

Reference

Kikugawa, K., Kato, T. and Hayatsu, H. (1986) Formation of mutagenic substances during smoking-and-drying (baikan) of bonito meat, *Eisei Kagaku*, 32, 379-383.

Para. 56.

We propose to change some words in the title of this part for consistency with the title of later sections and to modify para.56 in accordance with the general principles contained in paras 28-31 as follows:

IMPORTANT POINTS TO CONSIDER AND RECOMMENDATIONS ~~FOR PRODUCTION OF SMOKED FOOD~~ ON SMOKING

56. PAH content of smoked foods can be minimised by identifying and evaluating the important points to consider mentioned below, and by taking appropriate measures. An HACCP system might be applied.

Paras 57-61.

We also propose some modification on paras 57-61 for consistent terminology, avoiding duplication of description, and including as many recommendations as possible. Our proposal of description is described in the attachment of this comment paper.

Para. 57 f.

There is no relevant explanation of this paragraph in the corresponding section of "Fuel used in processing, paras 37-39.

Paras 58 c. and 60. j.

There is duplication on the description concerning filtering of the smoke between para.58. c. and 60. j.

Para. 60 g.

There is no relevant explanation of this paragraph in the corresponding section of "Processing", paras 44-52.

Para. 81.

We propose to modify para.81 in line with general principles contained in para.28-30 and JECFA's recommendation as follows. Regarding para.82-85, we propose modification as described in the attachment of this comment paper.

81. PAH content of foods by direct drying can be minimized by replacing direct drying with indirect drying, if possible or by identifying and evaluating the important points to consider mentioned below, and taking appropriate measures. An HACCP system might be applied.

Para. 82. b.

The paragraph 82. b. recommends to use hardwood rather than softwood in direct drying. However, the Annex III of the Code explains the effect of wood types only in smoking. If the effect in direct drying is not clear, this paragraph should be deleted.

Annex IV

Japan proposes to delete Annex IV of the Code since the important points of consider are summarized in the main text.

KENYA

The draft is acceptable to us. We propose that it should progress to the next stage.

PHILIPPINES

Page number in Annex	Paragraph number	Recommended Correction
Page 70	3	Furthermore, PAH can be present in the raw materials due to environmental contamination from the air ***by deposition on crops*** ~~or~~ ~~uptake by plants~~ from contaminated soils ***and transfer from water to fresh and marine invertebrates.*** Presence of PAH in ~~e.g.~~ vegetable oils can also originate from smoking and drying processes used to dry oil seeds prior to extraction.
Page 73	29	Information on PAH and conditions leading to presence of PAH of significance for food safety should be considered. The information would be on: ⇒ Possible sources of ~~contaminants such~~ PAH ***from the environment and*** during processing
Page 74	34	In general, changes in processing techniques can in some cases reduce the amount of PAH formed during processing and found in the processed food. Alteration of the process could be done in different ways after evaluation of the important points for consideration, e.g. by using indirect drying or smoking processes instead of direct drying or smoking; via the selection of fuel for drying or of wood species and other plant materials used in the smoking process; and by adjusting times and processing temperatures. ***Addition of activated carbon to coconut oil at the right dosage during the refining process can completely remove PAH contamination (Lozada et al. 1998).***
Page 74	37	For smoking of food, woods are normally used, but other types of fuels like bagasse (plant material from sugarcane), corn cob and coconut husk and shell are used (information from Thailand). Fuel used is an important point to consider for the potential contaminants of the food, e.g. the PAH contamination of food differs if woods or straw is used (Nielsen and Illerup, 2003). ***PAH contamination of oil seed is higher when using coconut husk compared coconut shell as fuel due to the higher lignin content of the husk (Lozada et al. 1998).***

THAILAND

- In para 25 and para 26, we wonder if it is appropriate to refer to the definitions in the website.
- In para 57b, to avoid confusion with the other type of fuel, the statement should be modified to be as follows:

  "When individual species of woods and other types of *plant materials* like bagasse (from sugarcane), corn cob and coconut husk and shell are use*d*, *their* use should be evaluated in the light of PAH contamination."
- In para 71, we wonder whether this para contains the examples of PAH contaminated food or not.

UNITED STATES OF AMERICA

GENERAL COMMENTS

The United States (U.S.) supports the development of the proposed Draft Code of Practice for the Reduction of Contamination of Foods with Polycyclic Aromatic Hydrocarbons (PAH) from Smoking and Direct Drying Processes for use by governments and national authorities to reduce PAH contamination in foods.

The U.S. suggests including information on smoke condensates (condensed smoke) as an alternative to direct smoking. Smoke condensates can be applied in a smoking process (i.e., in regenerated smoke), in a spraying/heating process, or as a liquid smoke flavour. Use of smoke condensates results in lower PAH levels than direct or indirect smoking (EFSA, 2008) and can have preservative effects (Munkner and Meyer, 1996; Prell et al., 1994). In addition, the U.S. suggests avoiding the use of the word "traditional" to exclude the use of smoke condensates. We note that the Proposed Draft Standard for Smoked Fish, Smoke-Flavoured Fish and Smoke-Dried Fish proposed by the 29th Session of the Codex Committee on Fish and Fishery Products (ALINORM 08/31/18, Appendix VII) defines smoked fish as having undergone one of several acceptable smoking processes, including "Smoking by regenerated smoke, . . . a process of treating fish by exposing it to smoke which is reproduced or regenerated by atomizing smoke condensate (liquid smoke) in a smoking chamber under the time and temperature conditions similar to those for hot or cold smoking." Thus, the definition of smoking in the proposed standard does not exclude smoking with smoke condensates. We have included specific comments below that address these issues further.

The U.S. also recommends that all Annexes be deleted when the document is forwarded to the Commission at Step 8, in keeping with the Committee's conclusion as summarized in paragraph 108 of the Report of the Second Session of the CCCF (ALINORM 08/31/41), namely that Appendices I to IV be retained [at Step 5] with a view to their revision or deletion from the [final] Code of Practice.

SPECIFIC COMMENTS[2]

Paragraph 9

The U.S. suggests changing "direct" to "directly" in sentence 3, as follows: "Consumers might smoke food and would often use a direct process, while drying can be done either directly or indirectly, e.g. in the sun or in a microwave oven."

Paragraph 12

The U.S. suggests removing the word "traditional" from the footnote to avoid confusion about the meaning of the word "traditional" and removing italics from "smoking process," as follows: "In the smoking process, the fuel used is often various wood species, in some cases with herbs and spices, e.g. juniper berries, to give a characteristic flavour."

Paragraph 13

The U.S. suggests adding the word "an" to the last sentence, as follows: "It should be underlined that any guidance given to minimize PAH should not lead to an increase in other contaminants."

[2] Underlining is used to highlight the location of changes in the text.

Paragraph 18

For clarity, the U.S. suggests revising this paragraph as follows: "*Plant materials, othe*r means non-wood fuels used in the smoking or drying process e.g. bagasse, corn cobs and coconut husk and shell."

Paragraph 20

The U.S. suggests replacing the reference with http://en.wikipedia.org/wiki/Pyrolysis.

Paragraph 21

The U.S. suggests inserting a new paragraph after paragraph 20 with a definition for "Smoke condensates," to read as follows: "*Smoke condensates* are products obtained by controlled thermal degradation of wood in a limited supply of oxygen (pyrolysis), subsequent condensation of the resulting smoke vapors, and fractionation of the resulting liquid products.

Paragraph 23

The U.S. suggests revising the definition by removing the phrase "the traditional type" as follows: "*Smoking, direct* is a smoking process where the smoke is developed in the chamber in which the food is processed."

Paragraph 26

The U.S. suggests revising the last sentence to read as follows: "They often grow in subtropical regions like Africa and also in Europe, Asia, North America, and South America."

Paragraph 29

The U.S. suggests adding the word "the" to sentence 1 to read as follows: "Information on PAH and conditions leading to the presence of PAH of significance for food safety should be considered."

Paragraph 30

The U.S. suggests revision of the third bullet to read as follows: "Compliance with relevant legislation and relevant codes of practice."

Paragraph 32

The U.S. suggests removing the word "traditional" from sentence 1, to read as follows: "Processes such as smoking and direct drying provide a wide variety of food textures and flavours and consequently a broader choice for consumers."

Paragraph 33

The U.S. suggests adding the word "is" to sentence 1 to read as follows: "The formation of PAH during smoking and drying is dependent on a number of variables, including . . ."

The U.S. suggests revising bullet 3 to read as follows: "Smoke generation process in relation to the temperature of pyrolysis and to airflow, in the case of a smoke generator (friction, smouldering, auto-combustion, thermostated plates) or in relation to other methods such as direct smoking or regenerated smoke from a smoke condensate."

The U.S. suggests revising the last bullet to read as follows: "Design of the smoking chamber and the equipment used for smoke/air mixture (which influence the smoke density in the smoking chamber."

Paragraph 34

The U.S. suggests adding the phrase "using smoke condensates" to sentence 2, to read as follows: "Alteration of the process could be done in different ways after evaluation of the important points for consideration, e.g. by using indirect drying or smoking processes instead of direct drying or smoking; by using smoke condensates; via the selection of fuel for drying or of wood species and other plant materials used in the smoking process; and by adjusting times and processing temperatures."

Paragraph 36

For clarity, the U.S. suggests revising sentence 1 to read as follows: "Foodstuffs such as meat and fish and some types of cheese have been smoked in many countries for centuries."

Paragraph 38

The U.S. notes that several references provide information on the use of wood species or other plant materials: EFSA, 2007; Stumpe-Viksna et al., 2008; Garcia-Falcon and Simal-Gandara, 2005. Therefore, the U.S. suggests modifying sentence 2 as follows: "However, it has not been possible to find generally accepted recommendations on the use of wood species or other plant materials."

Paragraph 40

For clarity, the U.S. suggests revising sentence 2 as follows: "As PAH is particle bound, a greater distance from the smoke source to the smoked food might reduce content of PAH in the food."

Paragraph 41

For clarity, the U.S. suggests revising sentence 1 as follows: "During direct smoking, fat dripping from the food into the source for the smoke, e.g. the glowing wood or other plant materials, might increase the content of PAH in the smoke and thereby in the smoked food."

Paragraph 43

The U.S. suggests revising sentences 1 and 2 as follows: "The organoleptic properties of the final products are an essential part of their characteristics. Changes of methods might not necessarily result in organoleptically acceptable products."

Paragraph 44

For clarity, the U.S. suggests eliminating this paragraph or rewriting it as follows: "Smoke is produced by pyrolysis of fuel at temperatures of around 300-450 °C in the glow zone. To produce smoke for smoking food, flames should be avoided, including by adjusting airflow."

Paragraph 45

For clarity, the U.S. suggests revising sentence 3 to read as follows: "Identifying the parameters critical for PAH formation in a specific process may potentially be useful to control PAH levels."

Paragraph 46

The U.S. suggests removing the phrase "The traditional" in sentence 1 and using the phrase "from approximately" with the temperature ranges in the bullets to reflect the fact that somewhat different ranges may be found in the literature. We also suggest including the word "hot" with "warm," and including hams as an example of this type of smoking/cooking process. (Bannerman, A.; http://en.wikipedia.org/wiki/Smoking_(food)).

The suggested changes would read as follows:

Smoking processes are often divided into three groups after the temperatures used in the smoke chamber during processes:

- Cold smoking with temperatures from approximately 18-25 °C. Used for e.g. some fish species and salami-type sausages
- Semi-warm with temperatures from approximately 30- 40 °C. Used for e.g. some fish species, bacon and pork loin
- Warm (or hot) smoking is smoking combined with heating resulting in a temperature of approximately 70-90 °C. Used for e.g. some fish species, hams, and frankfurter type sausages.

Paragraph 50

The U.S. notes that this paragraph states that both too much oxygen (sentence 2) and too little oxygen (sentence 3) produce PAH. The U.S. requests review of these two sentences by the working group to confirm that both statements are correct and/or to make any needed corrections.

Paragraph 51

In general, PAH formation increases with increasing temperature. The U.S. suggests adding the following sentence after sentence 2: "Generally, PAH formation increases with increasing temperature." (Varlet et al. 2007, http://en.wikipedia.org/wiki/Smoking_(food)).

Paragraph 52

The U.S. suggests adding a new paragraph after Paragraph 52, to read as follows: "Because smoke condensates are produced from smoke that is subjected to fractionation and purification, products made with condensed smoke generally have lower PAH levels than products made with freshly generated smoke. (EFSA, 2008)"

Paragraph 53

The U.S. suggests that sentence 2 in bullet 1 be revised to read as follows: "This can be achieved by washing (scrubbing), using a tar condenser, cooling or filtering, all of which can remove particle-bound PAH from the smoke."

Paragraph 54

To prevent confusion between the processes of washing product and washing/cooling smoke, the U.S. suggests revising sentence 2 and creating a new sentence 3 as follows: "Water-cooling is already used in the meat industry. Washing product after the process may remove PAH-containing particles from the surface of the product (Fabech, B and Larsen, J.C., 1986)."

Paragraph 55

The U.S. suggests revising sentence 2 as follows: "Fish products are often smoked as the whole fish with the skin, and if the skin is not eaten, some contamination is removed together with the skin."

Paragraph 57

The U.S. suggests adding a new bullet after the bullet "a." as follows: "Monitor the water content of the fuel. Lower water content may lead to rapid burning of fuel and higher PAH levels." (Simon et al., 2005).

The U.S. suggests replacing "use" with "used" in bullet "b." to read as follows: "When individual species of woods and other types of fuels like bagasse (from sugarcane), corn cob and coconut husk and shell are used, the use should be evaluated in light of PAH contamination."

The U.S. suggest insertion of "such" in bullet "d." to read as follows: "The use of other fuels: Avoiding the use of fuels such as diesel fuel, waste products, especially rubber tyres, olive residues and waste oil which may already contain significant levels of PAH."

The U.S. suggests deleting bullet "e." about particle size because this Code of Practice does not provide information about what effect wood particle size has on PAH production.

Paragraph 59

The U.S. questions whether the "heat source" mentioned in bullet "a." should be "smoke source," because the "heat source" used to warm the chamber for "warm" or "hot" smoking would not necessarily be a source of PAH. The same comment applies to paragraphs 33 and 40 as well.

Paragraph 60

For clarity, the U.S. suggests revising bullet "c." to read as follows: "Adjusting of the airflow to avoid excessive temperatures during smoke generation."

The U.S. also suggests adding a new bullet "l." to read as follows: "As an alternative to using freshly generated smoke, manufacturers can consider smoking with regenerated smoke from smoke condensates. They can also produce smoke-flavoured products by applying smoke condensates to foods, such as by spraying, dipping, injecting, or soaking."

Paragraph 61

The U.S. suggests combining and revising bullets "a." and "b." to read as follows: "The cleaning of the smoked product itself. In this case soot and particles containing PAH on the surface of the food may be removed by rinsing the product or immersing it into water. However, washing might lower organoleptic quality and increase microbiological risk." The suggested change deletes the term "water cooling" because it appears to refer to washing/cooling the smoke, rather than the smoked products, based on bullet 55.

Paragraph 67

The U.S. suggests revising sentence 2 as follows: "Contamination from drying in such places is expected to be a special problem for foodstuffs with a large surface area such as spices."

Paragraph 69

The U.S. suggests deleting the second "e.g.," in sentence 2 to read as follows: "In any event, fuels like e.g., diesel, rubber, tires, or waste oil, should generally not be used even as a partial component, as they may well lead to increased PAH levels."

Paragraph 70

The U.S. suggests changing "JECFA recommend" to "JECFA recommended" in sentence 2 to read as follows: "Direct contact of oil seeds or cereals with combustion products during drying processes has been found to result in the formation of PAH and should therefore be avoided, and JECFA recommended that contact of food with combustion gasses be minimized (WHO, 2006)."

Paragraph 72

Since PAH are also deposited from the gases onto the drying foods, "formation" should be changed to "formation or deposition" or "accumulation." Therefore, the U.S. suggests revising sentence 2 to read as follows: "Direct contact of oil seeds or cereals with combustion products during drying processes has been found to result in accumulation of PAH and should therefore be avoided."

Paragraph 73

The U.S. suggests changing the word "in" to "is" in sentence 3 to read as follows: "One example of PAH contamination from direct drying is contamination of vegetable oils (including olive residue oils) in which oil has been contaminated with PAH during technological processes."

Paragraph 74

The U.S. questions whether "bread" should be changed to "bread grains" or "cereal grains" in sentence 3 to read as follows: "For foods, indirect heating (external heat generation) and temperatures between 65 and 80 ºC are mainly used (cereal grains, malt etc.)."

Paragraph 75

The U.S. suggests deleting the sentence, "Temperature should be optimal for drying without the opportunity for PAH formation" and replacing it with "Too high a temperature (one that causes visible burning of the product) can cause PAH formation." The following sentence might also be added: "Where a system with a burner is being used, the temperature of the burner should be sufficient to allow complete combustion of the fuel, as incomplete combustion can lead to PAH in the drying gases." (deBot et al., 2004)

Paragraph 77

After Paragraph 77, the U.S. suggests adding a new paragraph as follows: "Ensure that complete burning of the fuel has occurred, by monitoring the gases for CO, monitoring the burner (if applicable) for soot accumulation, and checking burner settings and burner or fire temperatures." (deBot et al., 2004)

Paragraph 78

The U.S. suggests revising sentence 2 to read as follows: "JECFA recommended avoiding fire drying of seeds, and seeking alternative drying techniques."

Paragraph 82

For clarity, the U.S. suggests revising bullet "a." to read as follows: "The type and composition of fuel used to dry foods, e.g., the PAH content of the fuel."

The U.S. also suggests revising bullet "b." to read as follows: "If woods are used, use hard wood rather than softwood and do not use woods treated with chemicals, e.g., preserved wood, painted wood."

Paragraph 83

The U.S. suggests deleting this paragraph because the same point is made in Paragraph 85.

ATTACHMENT – Suggested References Provided in General and Specific Comments

EFSA. 2008. Polycyclic Aromatic Hydrocarbons in Food: Scientific Opinion of the Panel on Contaminants in the Food Chain. Question N° EFSA-Q-2007-136. Adopted on 9 June 2008. (Second paragraph under GENERAL COMMENTS, Paragraph 52 under SPECIFIC COMMENTS)

Munkner W and C Meyer. 1996. The use of liquid smoke: a new technology, Part 3, Investigation of shelf life of vacuum-packed smoked fish products processed with liquid smoke. Inf. Fischwirtsch 43(1): 40-45. (Second paragraph under GENERAL COMMENTS)

Prell PA, et al. 1984. Shelf Life of Sliced Bacon: Sensory Quality of Commercial Type with Liquid Smoke Versus Military Type with Hardwood Smoke. Defense Technical Information Center Report: NATICK/TR-84/050. (http://www.dtic.mil/srch/doc?collection=t2&id=ADA150640) (Second paragraph under GENERAL COMMEMTS)

Stumpe-Viksna I, et al. 2008. Polycyclic aromatic hydrocarbons in meat smoked with different types of wood. Food Chem110: 794-797. (Paragraph 38 under SPECIFIC COMMENTS)

Garcia-Falcon MS and J Simal-Gandara. 2005. Polycyclic aromatic hydrocarbons in smoke from different woods and their transfer during traditional smoking into chorizo sausages with collagen and tripe casings. Food Add Contam, January 2005; 22(1): 1–8. (Paragraph 38 under SPECIFIC COMMENTS)

http://en.wikipedia.org/wiki/Pyrolysis (Paragraph 20 under SPECIFIC COMMENTS)

http://en.wikipedia.org/wiki/Smoking_(food) (Paragraph 51 under SPECIFIC COMMENTS)

Bannerman A. Hot Smoking of Fish. Torry Advisory Note No. 82. Ministry of Agriculture, Fisheries, and Food. http://www.fao.org/wairdocs/tan/x5953e/x5953e01.htm#Definition%20of%20hot%20smoking (Paragraph 46 under SPECIFIC COMMENTS)

Simon R, et al. 2005. J. Sep. Sci. 28, 871–882. (Paragraph 57 under SPECIFIC COMMENTS)

Varlet V, et al. 2007. Organoleptic characterization and PAH content of salmon (Salmo salar) fillets smoked according to four industrial smoking techniques.

J Sci Food Ag. 87:847- 854. (Paragraph 51 under SPECIFIC COMMENTS)

deBot, P, et al. 2004. Study into drying processes for animal feed materials and HACCP. Product Board Animal Feed. November 2004. (http://www.pdv.nl/lmbinaries/kwaliteitsreeks_nr._101_study_into_drying_processes_for_animal_feed_materials_and_haccp.pdf). (Paragraphs 75 and 77 under SPECIFIC COMMENTS)