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Polycyclic Aromatic Hydrocarbons in Smoked Fish and Meat

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Abstract. Polycyclic aromatic hydrocarbons (PAH`s) can significantly influence smoked meat quality and safety. Toxicological studies on individual PAHs in animals, mainly on the PAH benzo(a)pyrene, have shown various toxicological effects. One significant source of PAHs in the human food chain is the smoking of meat and fish. Smoke not only gives special taste, colour and aroma to food, but also enhances preservation due to the dehydrating, bactericidal and antioxidant properties of smoke. Therefore the aim of our investigation was to determine the contents of PAH4 (benzo(a)antracene, benzo(a)pyrene, benzo(b)fluorantene, chrysene) in a variety of industrially smoked meat and fish products. Results were summarized and compared with maximum acceptable levels set by Draft European Commission regulation (EC) planned to be in force beginning 1.9. 2012.

Key words: aromatic, fish, hydrocarbons, meat, polycyclic, smoked

INTRODUCTION

PAHs are a class of complex chemicals that are formed and released during incomplete combustion or pyrolysis (burning) of organic matter such as waste or food during industrial processes and other human activities. PAHs are also formed in natural processes, such as carbonisation.

Polycyclic aromatic hydrocarbons (PAHs) are generally classified as relatively persistent organic environmental contaminants (Deshpande, 2002; Harvey, 1997; Martson et al., 2001). Food is a significant source of BaP in Europe due to PAHs in oils, fats and cereals which represent a high percentage of European diets (Sikorski, 2004).

Smoking is one of the oldest technologies for the conservation of meat and fish products. Today it is supposed that the technology is applied in many forms to treat 40–60% of the total amount of meat products and 15% of fish. Smoking is defined as the process of penetration of volatiles resulting from thermal destruction of wood into the surface of meat or fish products.

The objective of this article was to determine the level of the polycyclic aromatic hydrocarbon in representative samples of traditional and industrial smoked fish and meat products to be sold in the Latvian Republic.

MATERIALS AND METHODS

Samples and sampling

All commercial samples were purchased from local outlets. To collect representative samples of animal origin products in Latvia, a total of 22 samples of smoked meat products and 29 samples of smoked fish products were analysed. Samples of approximately 150 g of smoked products were taken. Packaging of samples followed the Commission Regulation (EC) No 333/2007 (Guillen et al., 1996; Commission Regulation (EC) No 333/2007). Afterwards samples were homogenated in a laboratory of „Sigra" using sample mills.

Chemical

For the sample treatment, cyclohexane, N,N-dimethylformamide (DMF), methanol, potassium hydroxide, acetonitrile, anhydrous Na_2SO_4 and silica solid phase extraction (SPE) (500 mg) were purchased from Sigma-Aldrich.

Analysis of PAHs

In this study meat and fish samples were analyzed using the method for HPLC (*EFSA Journal***,** 2008; Simko, 2002). Homogenized samples were hydrolyzed with the solution of potassium hydroxide in ethanol for 2 hours in 40°C, and filtered and extracted with cyclohexane. The cyclohexane solution was washed with water and then with a mix solution of methanol/water (4:1). The cyclohexane liquid extraction with N,N-dimethylformamide/water (9:1) solution was used. Afterwards, repeatedly combined DMF layer extraction with cyclohexane and extract evaporating by rotation evaporator and diluting in cyclohexane were applied. The end stages of analysis were extract purification using a Silica SPE column and evaporating and diluting in phase (acetonitrile).

Statistical analysis

All data are presented as mean with standard deviation; significance was set at $P < 0.05$.

RESULTS AND DISCUSSION

PAH4 in smoked meat products

In this study, 22 samples of smoked different meat products were analysed and the concentrations of the PAH4 were determined.

Figure 1 clearly shows that analyzed samples contain PAH4 in concentrations below the EU permitted maximum limit (Sikorski, 2004). The highest content of PAH4 (Fig.1) was detected in breakfast ham (8, 22 μg kg^{-1}), the lowest, in smoked pork chop (1, 18 μg kg^{-1}). This study clearly indicates that the production of smoked meat products with PAH4 levels less than 10 μg kg^{-1} is possible in non-intensely smoked products. Taking into account properties of several PAH compounds (i.e PAH4), the Scientific Committee on Food (SCF) recommended that the PAH contents in smoked meat products should be as low as reasonably achievable (ALARA).

Figure 2 shows that samples of industrial and traditional smoked fish contained PAH4 concentrations. These concentrations do not exceed amended Regulation (EC) No 1881/2006 maximum levels of PAH4 (30.0 μg kg^{-1}) for smoked fish.

On the basis of obtained results it was found that traditional smoked Baltic herring samples did not exceed PAH4, the EU maximum acceptable level, either. Referring to the scomber samples, the studied samples of traditional smoking (scomber 1) contained PAH4 in concentrations substantially higher in comparison with industrial smoking (scomber 2), but not exceeding the permitted level.

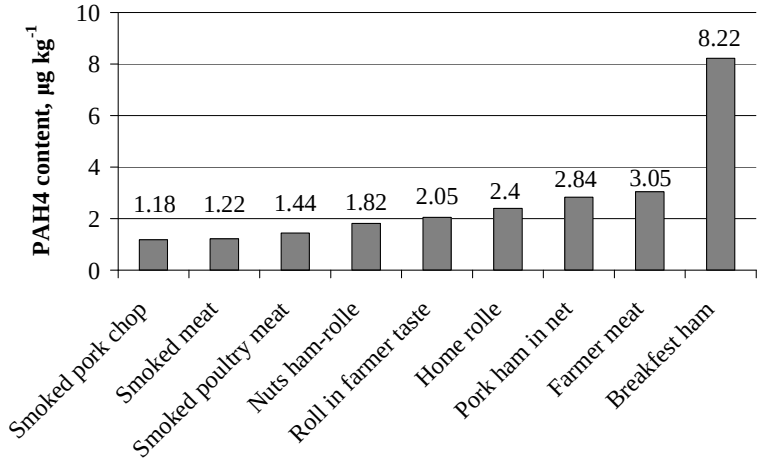

Figure 1. Average PAH4 content in industrial smoked meat products PAH4.

In total, 29 samples of traditional (n = 11) and industrial (n = 18) smoked fish products were analyzed for PAH4 content.

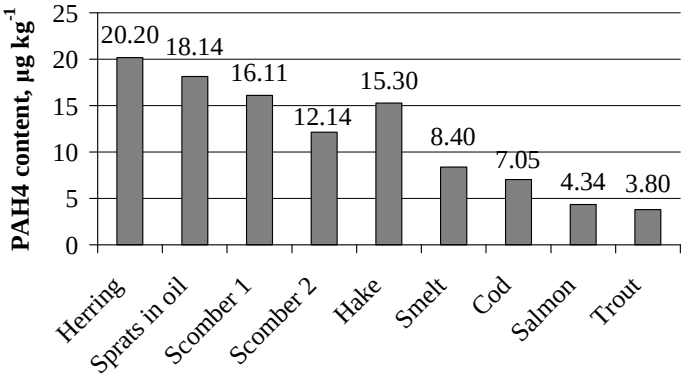

Figure 2. Average PAH4 content in industrial and traditional smoked fish products.

On the basis of obtained results it was found that traditional smoked Baltic herring samples did not exceed PAH4, the EU maximum acceptable level. Referring to the scomber samples, the studied samples of traditional smoking (scomber 1) contained PAH4 in concentrations substantially higher in comparison with industrial smoking (scomber 2), but not exceeding the permitted level.

The other samples of fish smoked by indirect technique, using smoke from an external smoke generator, had PAH4 levels below the maximum limit, i.e., from 15.30 (µg kg^{-1}) (hake) to 380 (µg kg^{-1}) (trout).

The amount of PAHs formed during the processing of fish depends mostly on the conditions of smoking. In traditional smoking, smoke is generated at the bottom of an oven and the food is placed directly over the smoking wood. In modern industrial smoking ovens, smoke is generated in a separate chamber and fed into the smoking chamber where the products are placed. This method promotes better control of the smoking process (Vaz-Velho, 2003).

Based on the conclusions of EFSA, the current system of using benzo(a)pyrene as the only marker for the group of polycyclic aromatic hydrocarbons cannot be maintained. An amendment of Regulation (EC) No 1881/2006 is therefore necessary. New maximum levels for the sum of four substances (PAH4) (benzo(a)pyrene, benzo(a)antracene, benzo(b)fluorantene and crysene) should be introduced. Such a decision and draft Commission Regulation was accepted by EC section of Toxicology meeting on 08.04.2011. Our investigations will assist further development of this amended new Regulation.

CONCLUSIONS

Our investigations are an investment in promoting the enforcement of amended EC Regulation No 1881/2006 on maximum levels of PAH4.

The level of PAH4 of the traditionally smoked fish products is higher in comparison with industrially smoked fish products

The level of PAH4 of the industrially smoked meat and fish products does not exceed maximum levels of PAH4 established in amended EC Regulation No 1881/2006.

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