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Non-dioxin like polychlorinated biphenyls in mackerel (*Scomber scombrus*) available on the Serbian market

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Abstract

Mackerel is rich in omega-3 fatty acids, but this fish may be contaminated with environmental pollutants. The aim of this study was to evaluate concentrations of non-dioxin like polychlorinated biphenyls (ndl-PCBs) in 160 samples of mackerel available on the Serbian market. Average and maximum ndl-PCB concentrations were 7.9 ng/g and 74 ng/g, respectively. A higher average level of ndl-PCBs was found in mackerel from Spain, but this was still three times lower than the permitted level. We conclude that levels of ndl-PCBs in mackerel available on the Serbian market are acceptable.

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1. Introduction

Fish has an important role in the human diet because it is rich in proteins, minerals, vitamins and unsaturated essential fatty acids, especially polyunsaturated fatty acids (PUFAs). Due to health benefits, fish consumption has

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increased in Serbia in recent years¹. Besides trout and carp, a significant proportion of the Serbian diet consists of marine fish - hake, sprat and mackerel. Mackerel is an important fish that is consumed worldwide. As an oily fish, it is a rich source of omega-3 fatty acids². On the other hand, fish and fishery products may be contaminated with environmental pollutants such as polychlorinated biphenyls³.

Polychlorinated biphenyls are a mixture of organohalogen compounds. They have been used in industry since the thirties of the 20th century. Since then, their production increased until the seventies, when research after accidents (Japan, USA, Slovenia) pointed to their toxicity^{4,5}. Of the total intake of PCBs in the humans, almost 90% come from consumed food^{6,7}. Polychlorinated biphenyls are particularly accumulated in fish and marine mammals, reaching levels which may be several thousand times larger than those in the water. Toxic effects that result from the exposure to PCBs include effects on the liver, thyroid, skin, eyes, immune system, nervous system, and prolonged exposure to these compounds can induce reproductive toxicity and carcinogenicity.

All PCBs can be classified on the basis of toxicity depending on chemical structure similarity to the PCB dioxin - dl-PCBs (dioxin like PCBs), and PCBs which are not similar to dioxin. In the environment and consequently in food, ndl-PCBs are far more common. Most often, their detection is based on so-called indicator congeners which include ndl-PCBs 28, 52, 101, 153, 138 and 180. Very often in the scientific papers, PCB congener 118, which belongs to the dl-PCBs, is also added to this group.

The aim of this study was to evaluate concentrations of ndl-PCBs in mackerel imported to the Serbian market from different countries.

2. Materials and methods

Concentrations of ndl-PCBs were measured in mackerel available on Serbian market.

In total, 160 mackerel samples from seven countries were analysed. These data were collected during the period 2011–2014. The origin of analysed fish was Spain, Ireland, Iceland, the Netherlands, Great Britain, Norway and Canada. Measurements were completed at the Institute of Meat Hygiene and Technology, using analytical methodology in compliance with the standard ISO 17025.

Edible parts of fish were chopped into 2–3 cm thick portions and homogenized. ndl-PCBs were extracted with petrol ether and separated in columns filled with partially deactivated alumina. The eluate was evaporated to an appropriate volume. An aliquot of 1 μ l was injected into a gas chromatograph coupled with electron capture detector. GC Varian Model 3800 equipped with a ⁶³Ni electron capture detector and Zebron ZB 1 column (30 m x 0.25 mm i.d. and 0.25 μ m film thickness) were used for analysis of ndl-PCBs (congeners 28, 52, 101, 118, 138, 153, and 180). Operating conditions were the following: injector 250°C; detector 300°C; column oven program: initial 50°C raised to 230°C. Data acquisition was performed by Varian Star software.

Limit of detection was 1 ng/g. Analytical quality control was achieved by using certified reference material ERM-BB446.

3. Results and discussion

Ndl-PCBs were detected in 64% of samples ($n = 160$). Detectable ndl-PCB was found in a high percentage (87%) of mackerel from Spain. In mackerel from Iceland and Norway, less than half of analysed mackerel had concentrations of ndl-PCBs above the limit of detection (1 ng/g).

Minimum, maximum and average concentrations of ndl-PCBs are shown in Table 1.

Table 1. Concentrations of ndl-PCBs in mackerel.

Origin of mackerel	No of samples	No of samples with detected ndl-PCBs	ndl-PCB, ng/g		
			min	max	average
The Netherlands	12	8	< 1	13	4.0
Ireland	13	7	< 1	41	5.7
Island	12	2	< 1	1	0.2
Canada	19	10	< 1	68	8.2
Norway	19	7	< 1	18	2.6
Spain	60	52	< 1	74	26.0
Great Britain	25	16	< 1	70	8.7
Σ	160	102	< 1	74	7.9

The average ndl-PCB concentration was 7.9 ng/g. Mackerel from Spain had high average level of ndl-PCBs – 26 ng/g, and the minimum average level was measured in mackerel from Island – 0.2 ng/g. According to EU regulative 1881/2006⁸ and Serbian legislation⁹ from 2014, the maximum residue limit for ndl-PCBs is 75 ng/g. Concentrations of ndl-PCBs were less than this permitted value in all analyzed mackerel. The maximum concentration of ndl-PCBs detected was 74 ng/g, in mackerel from Spain. In mackerel from other countries, we found average concentrations in the range of 0.2-8.9 ng/g. Fromberg et al. found similar values in mackerel from Denmark – 10 ng/g¹⁰. Higher levels of ndl-PCBs than in our study, of 23.4 ng/g, were published by EFSA in different kinds of fish, based on the data from 18 EU member states in the period 1995-2008¹¹. In river fish, Djjinovic et al. found an average of 40.9 ng/g ndl-PCBs in silver bream from Danube river, while in a different kind of fish, barbel, from the same river, the average value of ndl-PCBs was similar to the results of our study - 7.2 ng/g¹².

4. Conclusion

Having in mind the increase of fish consumption in Serbia and the contribution of mackerel to the diet, concentrations of ndl-PCBs in mackerel in Serbian market are acceptable. Mackerel from Spain contained a higher average level of ndl-PCBs, three times higher than in mackerel from other origins, but this value was still three times lower than the maximum permitted level.

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