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COMPARISION OF MERCURY CONCENTRATION IN MEAT PRODUCTS OF DIFFERENT ORIGIN

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ABSTRACT

In this study the concentration of mercury in the Malokarpatska and Lovecka salami during the technological processing with comparison of the raw materials originating from domestic and foreign production was determined. Mercury content was determined by atomic absorption spectrometry. The highest concentration of mercury in raw materials (beef, pork, pork bacon) was detected in beef from foreign production. Increasing concentrations of mercury was found after the addition of additives, spices and curing compounds causing a threefold increase in the concentration of mercury in final products.

Keywords: Mercury, meat, meat products, AAS

INTRODUCTION

Meat is a very rich and convenient source of nutrients including also a large extent of microelements. Chemical composition of meat depends on both the kind and degree of the animal feeding. The requirement for mineral compounds depends on the age, physiological state, feed intake as well as living conditions (**Akan *et al.*, 2010**). Meat and meat products are important for human diet in many parts of the world because they contribute to solve the global food problem and provide the well-known proteins, minerals, vitamins and trace element contents (**Alturiqi, Albedair, 2012**).
The risk associated with the exposure to heavy metals present in food product had aroused widespread concern in human health. The risk of heavy metal contamination in meat is of great concern for both food safety and human health because of the toxic nature of these metals as relatively minute concentrations (**Santhi *et al.*, 2008**). Contamination with heavy metals is a serious threat because of their toxicity, bioaccumulation and biomagnifications in food chain (**Demirezen, Uruç, 2006**). In recent years, much attention has been focused on the concentration of heavy metals in fish and other foods in order to check for those hazardous to human health (**Farkas *et al.*, 2003;Mansour and Sidky, 2002; Moiseenko and Kudryavtseva, 2001**).
Mercury occurs as elemental mercury and as inorganic and organic compounds, all having different toxicological properties. Total mercury can be analyzed in water, air and biological material (**Massányi *et al.*, 2003**). The toxic properties of mercury vapour are due to mercury accumulation in the brain causing neurological signs. At high exposure levels, mercury tremor is accompanied by severe behavioural and personality changes, increased excitability, loss of memory and insomnia (**Nordberg *et al.*, 2007**).
The aim of this study was the assessment of Hg concentration in the traditional and popular meat products consumed in Slovak republic. This study is carried out to determine the levels of mercury in Lovecka and Malokarpatska salami during the technological processing, and the raw materials originating from domestic and foreign production were compared.

MATERIAL AND METHODS

Sample collection

To reach representative samples average composition and characteristics of the goods were analyzed. The concentration of mercury was determined in total 180 samples of raw materials and final product respectively. The collection sample during the manufacturing process was carried out under the following scheme.
"Malokarpatska salami" – basic raw material (beef, pork and pork bacon) was collected; than samples of mixed meat with additives (salt, spice extracts, Sodium Nitrite, highlighter flavor, *Lactobacillus*) and finally the actual sample of the final product after heat treatment were analyzed.
"Lovecka salami" – basic raw material (beef, pork and pork bacon) was collected; than samples of mixed meat with additives (salt, Sodium Ascorbate, Erythorbic acid, ground black pepper, sugar, garlic, starter culture) and finally the actual sample of the final product after heat treatment, cooling to 25°C and drying in climates with aw = 0.95 were analyze.

Sample preparation

Collected samples were packet to plastic bags, and frozen (-18°C). 30-50 mg of meat or homogenized meat samples and final products were used in the protocol. The material was not mineralized before the measurement and the analyses were performed as the wet weight (w/w) of the material. The samples were supplemented with two additives: additive M (Wako Pure Chemicals Industries Ltd. for NIC 286-61845) and additive B (Wako Pure Chemicals Industries Ltd. for 282- 98 62665) to minimize potential interferences. Limit of detection established for the whole procedure was 0.170 ng of total Hg. The accuracy of the method was checked against the certified reference material (BCR-463). Final results were given in ppb ($\mu g.g^{-1}$) for meat and other samples.

Elemental analysis of samples

Concentrations of total mercury in samples were measured with cold vapour atomic absorption spectrometer (Nippon Instrument Corporation MA-2).

Statistical analyses

Data collected were presented as mean, standard deviation, coefficient of variation, standard error of mean. The significant differences between means were calculated by a one way analyses of variance Duncan´s multiple range test at $P<0.05$, $P<0.01$, $P<0.001$

RESULTS AND DISCUSSION

The mean values, standard deviations, standard error of mean, coefficient of variation of mercury concentration in Malokarpatska salami are given in Table 1. The level of mercury contents in beef from domestic and foreign production ranged between 2.751±1.095 ppb and 3.657±0.642 ppb respectively. It was noticed that Hg content in the beef of foreign origin was significantly (P<0.05) higher compared to those from the domestic production. These results are in concordance with the data obtained by Sell et al. 1975 where total mercury was determined in beef from geographical areas of North Dakota (4 to 6 ppb). The levels of mercury in beef observed by **Alturiqi*et al.*,(2012)** were lower compared to our results. Mercury contents in this study ranged between 0.009 – 0.087 ppb for beef.

Mercury was present in pork from domestic and foreign production in the range from 1.494 ppb to 1.842 ppb. Hg data showed noticeable insignificance difference between Hg content in pork from domestic production and pork from foreign production. Compared to **Vos *et al.*, (1986)**, the mercury concentrations found in the present our study are low (mercury content in meat of swine 5.023 ppb).

Mean contents of mercury in pork bacon from foreign production (1.971±0.473 ppb) were higher than in pork bacon from domestic production (1.364±0.262 ppb). There was a significant variation (P<0.01) between Hg content in collected pork samples from domestic and foreign production. For raw materials the highest concentrations of mercury was detected in beef from foreign production and beef from domestic production, respectively (3.657 ppb, 2.751 ppb).

The average concentration of mercury was higher in homogenized samples with addition additives and spices 6.159±1.530 ppb and final product Malokarpatska salami (9.295±2.367 ppb). Hg concentration in homogenized samples from raw materials from domestic production was higher than mercury content in homogenized samples from raw materials from foreign production and final product from foreign production, respectively (6.159±1.530 ppb; 5.009±0.779 ppb). Hg contents in the homogenized samples from foreign production were significantly (P<0.05) lower compared to those from the domestic production. Mercury content in the final product from domestic production was significantly (P<0.0001) higher compared to final product from foreign production. Hg concentrations obtained from this study were lower than the permitted mercury limit of **Codex Alimentarium of the Slovak republic**(0.05 mg.kg^{-1}).

Table 1 Basic variation statistical characteristics of mercury concentration in the rawmaterials and finalproduct "Malokarpatska" salami

Statistical value	Beef/Hg		Pork/Hg		Pork bacon/Hg		homogenized samples/Hg		final product/Hg	
	D	F	D	F	D	F	D	F	D	F
mean	2.751	3.657	1.494	1.842	1.364	1.971	6.159	5.009	9.295	4.938
SD	1.095	0.642	0.511	0.411	0.262	0.473	1.530	0.779	2.367	0.636
SEM	0.346	0.203	0.161	0.130	0.0828	0.149	0.484	0.247	0.748	0.201
CV	39.82	17.55	34.17	22.31	19.21	24.00	24.85	15.57	25.47	12.89
P value	0.0368 (P<0.05)		0.1107 (NS)		0.0023 (P<0.01)		0.0485 (P<0.05)		P< 0.0001	

Legend: SD – standard deviation, CV(%) – coefficient of variation, SEM – standard error of mean, D - domestic and F - foreign production, Hg - mercury

The concentrations of mercury observed in the Lovecka salami are presented in Table 2. The mean Hg concentrations in beef ranged between 2.536 ppb from domestic production and 3.773 from foreign production. The mean level of Hg in the beef from foreign production was slightly higher (P<0.01) than in beef from domestic production. The concentrations of mercury in the beef reported in this study were higher as those determined by **Akan *et al.*,(2010)** (1.045 ppb) and **Alturiqi *et al.*,(2012)** (0.023 ppb). **Aranha, (1994)** reported significantly higher amounts of mercury in the muscle from cattle sampled around the refineries (4.223 ppb).

Hg concentration in the pork from domestic production (1.297 ppb) was lower than Hg concentration in the pork from foreign production (1.421 ppb) but there noticeable insignificance differences between Hg content in collected pork samples. **Abou-Arab, (2001)** observed that mean mercury concentration in Egyptian meat was in the range 1.865 – 1.989 ppb.

The highest mercury concentration was found in the final product from domestic production 9.406±2.171 ppb and lower value was observed in the pork bacon from foreign production 1.057±0.0473 ppb. Hg concentration obtained from our study was lower than the permitted mercury limit of 1.0 mg/kg **(EC, 2001)**.

Table 2 Basic variation statistical characteristics of mercury concentration in the rawmaterials and finalproduct "Lovecka" salami

Statistical value	Beef/Hg		Pork/Hg		Pork bacon/Hg		homogenized samples/Hg		final product/Hg	
	D	F	D	F	D	F	D	F	D	F
Mean	2.536	3.773	1.297	1.421	1.728	1.057	8.417	6.011	9.406	6.757
SD	1.080	0.326	0.481	0.0776	0.405	0.0473	2.770	0.489	2.171	0.675
SEM	0.3415	0.103	0.152	0.0245	0.128	0.0149	0.876	0.155	0.686	0.213
CV	42.58	8.65	37.07	5.46	23.43	4.47	32.91	8.15	23.08	9.98
P value	0.0027 (P<0.01)		0.2324 (NS)		P< 0.0001		0.0145 (P<0,05)		0.0017 (P<0.01)	

Legend: SD – standard deviation, CV(%) – coefficient of variation, SEM – standard error of mean, D - domestic and F - foreign production, Hg - mercury

Due to the grazing of cattle on contaminated soil, higher levels of metals have been found in beef **(Sabir and Khan, 2003)**. In Nigeria, the main source of metals in chicken meat and meat of goat, sheep and beef arises from contamination of feed and drinking water **(Akan *et al.*, 2010)**. In animal food products one of the most important factors that influence the content of toxic metals in animal products is the life span of the animals. Animals with long life span such as horse, older cattle and game, can accumulate some inorganic contaminants **(Lukáč and Massányi, 2011)**. In final products the highest significant levels of mercury were found. Technological treatments are important for levels of mercury in meat products. Heavy metals transfer to animals and humans through the food chain JECFA, 2004.

CONCLUSION

In this study the levels of mercury in meat products from Slovak republic were determined. The obtained results suggested that from raw materials the highest concentration of mercury in the beef from foreign production in the Malokarpatska and Lovecka salami, respectively (3.657 ppb, 3.773 ppb) was found. Ingestion of contaminants with various environmental pollutants, especially heavy metals by animals causes deposition of residues in meat. Technological process of processing meat can create a potential source of heavy metals in final products.

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