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Impact of Environmental Pollution on Contamination of Locally Grown Roughage

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Abstract

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Contamination of ration components and roughage fed to dairy cows and finishing bulls in two different agricultural ecosystems in the district of Uherské Hradiště (localities Buchlovice and Stupava) was monitored. Whereas the site Buchlovice was characterised by intensive agricultural production, the site Stupava was located in the protective zone of the Koryčany water reservoir and ecological agriculture was practised in a part of this area. Materials used for analyses included irrigation water, grass growth, haylage, wheat, roughage, preserved feeds and trough samples of feed. Samples of alfalfa and clover were also collected as ration components and bioindicators of plant origin. From each sample kind and/or sampling site 15 samples were collected. In addition to feeds, bovine milk and beef liver and muscle (*m. longissimus dorsi*) samples were analysed (10 samples of animal material). Imissions were measured by the mobile laboratory of Regional Hygienic Services, Brno, allowing the determination of SO_2, NO_x, CO, O_3, fly ash. The samples were analysed for polychlorinated biphenyls (PCB) by high resolution gas chromatography with electron capture detection. Also tested for PCB residues were milk and tissue samples collected from dairy cows and bulls. The concentrations of indicator PCB congeners did not exceed the safety limit in any of the sampling areas (mean concentrations of PCB in feed between 1-2 $\mu g \cdot kg^{-1}$; mean concentration of PCB and animal tissues between 2-9 $\mu g \cdot kg^{-1}$). Calculation of the transfer coefficient Q proved to be a suitable tool for the assessment of residue transfer (dairy cows 0.2-1.0; bulls 0.3-1.0). Feed was identified as an important contamination source for animal tissues and milk.

Polychlorinated biphenyls, agricultural ecosystem, transfer coefficient Q, food chains

Like other ecosystems, the agricultural ecosystem is exposed to the action of contaminating xenobiotics. In accordance with the world-wide tendencies, criteria for the assessment of the burden by xenobiotics are currently tightened in the Czech Republic to prevent possible damage to human and animal health. Also significant are the effects of pollutants on ecological aspects of the agricultural landscape.

In addition to some extrinsic factors of agricultural ecosystems, the transfer of chemical xenobiotics in food chains depends also on intrinsic factors of the agricultural production. The extrinsic factors include the pollution of air, dry and wet imissions, and surface water; the intrinsic factors are associated with biological, physical, chemical and biological characteristics of soil, with the technology of agricultural production, and with zoohygienic conditions. The intrinsic factors become more significant in areas with intensive agricultural production, in which ecological dysbalance of the agricultural ecosystem often develops. Its major cause are high concentration of farm animals, inadequate handling of wastes from animal production, and excessive use of fertilisers. Such activities result in a complex soil devastation, biological dysbalance in farm animal herds, and penetration of contaminants into feeds and subsequently into raw materials and foods of plant and animal origin (Zima et al. 1994).

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The individual elements of the food chain can be contaminated by inorganic or organic chemicals. Of the latter, monitoring concentrates particularly on polychlorinated biphenyls (PCB) and polyaromatic condensed hydrocarbons (PAH).

PCB represent a mixture of congeners the concentrations of which in tested materials may differ from each other by several orders of magnitude. Approximately 150 congeners can be detected in environmental samples. Investigations in agricultural ecosystems usually concentrate on seven indicator congeners (PCB 28, 52, 101, 118, 138, 153, and 180). Reviews completed in several countries indicate that approximately 2% of the total amount of PCB have penetrated into the environment; expressed in absolute values it is approximately 10×10^9 kg. Considering their physical and chemical characteristics, i.e. low water solubility, long persistence in the environment, and high resistance to chemical degradation, it is understandable that high accumulation of PCB was repeatedly demonstrated in food chains of various animal species (Elliot et al.1991; O´Connor et al. 1990). These authors used monitoring data for the assessment of the occurrence of organochlorine chemicals in porcine and bovine tissues in 1991 through 1997. The most marked decrease by up to 17% was observed for the concentrations of PCB 153, HCB, α–HCH, and p,p´-DDE in the samples collected from cattle and the authors suggested the use of monitoring data for risk assessment (Glynn et al. 2000). PCB metabolism and burden in lactating dairy cows fed naturally contaminated feeds for four months were investigated by Thomas et al. (1999). Daily intake (mg/day) was found to represent 0.9 to 1.5% of the total burden for the persistent congener PCB 153 and up to 43% of the total burden for readily metabolised congeners (PCB 52). Balance studies demonstrated that PCB was metabolised completely, while other congeners passed into milk and were demonstrable in milk products. Ciberej et al. (1999) found increased concentrations of PCB, including the congener 28, in tissues of wild animals living in the contaminated area around the chemical factory Chemko Strážske (Slovakia) where a PCB-containing product had been manufactured in the past and attributed them to secondary contamination from the earlier heavily polluted ecosystem. Because of existing industrial production in the region, ecosystem in the sampling site was under long-term load of both commercial mixtures (Delor 103 and Delor 106). Taking into account this fact one can explain observed concentration of indicators congeners which are part of both mixtures. Ciberej et al. (1999) have published similar findings.

Monitoring of concentrations of selected analytes in all ecoblocks of the production of foods of plant and animal origin is necessary for comprehensive assessment of food chain contamination. As far as beef is concerned, the extrinsic factors to be monitored include air contamination, composition of imissions, and contamination of drinking and irrigation water, roughage, and feed supplements. Similarly, the intrinsic factors to be monitored include soil, animal wastes, barn indoor environment, and animal body fluids and tissues (Zima et al. 1994; Vávrová et al. 1999).

Transfer studies in defined agrarian ecosystems allow the identification of the most critical element of the food chain. Of particular importance are data on the feed → tissue transfer. Best suited for their assessment is the transfer coefficient Q calculated as the ratio between mean mass of the analyte in animal tissues and its concentration in plant mass. This calculation allows monitoring of penetration of xenobiotics into the food chain and is also useful for pilot studies that should precede implementation of more extensive monitoring programmes (Kolektiv 1998; Kolektiv 1999).

Materials and Methods

Two sampling sites in the district of Uherské Hradiště were selected for the monitoring of dynamics of organic pollutants in an agricultural ecosystem. Whereas the site Buchlovice was characterised by intensive agricultural production, the site Stupava was located in the protective zone of the Koryčany water reservoir and ecological agriculture was practised in a part of this area.

Materials for analyses included irrigation water, grass growth, haylage, wheat, roughage, trough samples of feed and preserved feeds. Samples of alfalfa and clover were also collected as ration components and bioindicators of plant origin. From each sample kind and/or sampling site 10 samples were collected.

The collected samples were analysed for indicator PCB congeners. The relevance of such analyses resulted from the fact that the area under study harboured recultivated dumps of wastes from a paint manufacturing factory where Delor 106 (a commercial PCB-containing product manufactured in Slovakia) had been used up to the end of 1987.

In addition to feeds, bovine milk and beef liver and muscle (*m. longissimus dorsi*) samples were analysed. Two litre volumes of milk samples were collected at the morning milking. The weight of animal tissue samples ranged between 450 and 600 g. The interval between sampling and analyses never exceeded 12 h and the samples were stored in a refrigerator during this period. Standard operation procedures (SOP), which are a part of the laboratory's quality manual (Vávrová 1999a) were strictly adhered to.

PCB, separated from 1 litre of water sample each by triple extraction with hexane (50, 30, and 30 ml, respectively) were cleaned in an aluminium oxide column and subsequently with sulphuric acid. The cleaned samples were condensed in a rotary vacuum evaporator and the residue was diluted in 1 ml of isooctane. Results of analyses of plant materials were converted to 85% dry matter. Dried, approximately 30-g samples were extracted four times with 70-ml volumes of a hexane-acetone mixture (94 : 6) and further processed as described for water samples. Milk samples were processed as follows: volumes of 200 ml were heated to 40 °C and milk fat was separated by low-temperature centrifugation at 6 000 rpm for 15 min. The separated fat layer was triturated with anhydrous sodium sulphate and extracted with petroleum ether-diethylether mixture (96 : 4). The extraction was enhanced by sonication. The solvent was removed in a rotary vacuum evaporator and 100 to 200 mg of the residue was weighed for clean up in a florisil column. The clean-up procedure was completed with sulphuric acid. Samples of animal tissues were homogenised, triturated with anhydrous sodium sulphate and extracted three times with petroleum ether- diethylether mixture (96 : 4). The extraction was enhanced by sonication. Clean up was carried out as described for milk samples. Residues obtained by extraction of the milk and tissue samples were dissolved in isooctane. All the samples were measured in duplicates. Means of 15 analyses of water or plant material samples and 10 analyses of animal material samples are given in the tables.

PCB were determined by high resolution gas chromatography (chromatograph HP 5890, Series II) with electron capture detection using the following parameters: capillary column HP 5, column length 60 m, column inside diameter 0.25 µm; film thickness 0.2 µm, split/splitless injector, injection temperature 250 °C; temperature mode 40 °C for 40 min, increase to 180 °C at 30 °C per min and to 280 ° C at 2 °C per min, and hold at 280 °C for 10 min; detector 63Ni ECD, detector temperature 300 °C; constant flow at 1.0 m per min. Standards supplied by Dr. Ehrenstorfer (Germany) were used for congener identification. QA/QC conditions were assured by use of certified reference materials CRM Dr. Ehrenstorfer (Germany) containing the analytes under study in freeze-dried bovine liver tissue, freeze-dried beef, and bovine fat. Moreover, national reference materials tested for worthiness by the National Reference Laboratory at the Institute of Chemical Technology in Prague were used. The detection limit for PCB congeners was 1 $\mu g \cdot kg^{-1}$. Arbitrary values of 0.5 $\mu g \cdot kg^{-1}$ were substituted for concentrations below the detection limit in the calculations of means.

Imissions were measured by the mobile laboratory of Regional Hygienic Services, Brno, allowing the determination of SO_2, NO_x, CO, O_3 , fly ash and recording of air temperature and atmospheric pressure.

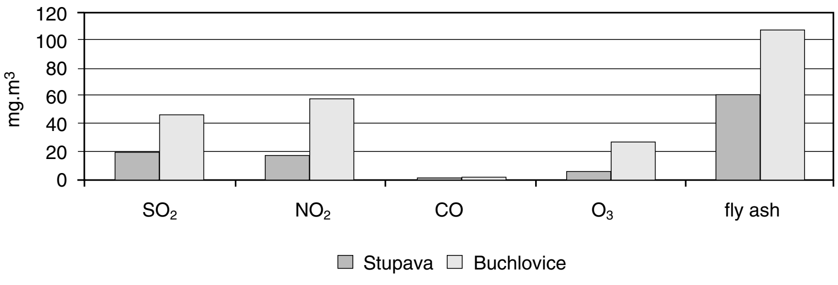

Fig. 1. Imission burden in the district of Uherské Hradiště ($mg \cdot m^{-3}$)

Results and Discussion

Dynamics of penetration of PCB into the food chain were investigated in the district of Uherské Hradiště, in which the pollution of the agricultural ecosystem by organics had been monitored for a long period. Two sampling sites were selected to avoid effects of bioclimatological factors. One of them was on the windward side of a paint producing

Table 1
Mean concentrations of PCB indicator congeners in irrigation water ($ng \cdot l^{-1}$) and grass growth ($\mu g \cdot kg^{-1}$ 85% dry matter)

PCB congeners		**Sampling site**			
		Boršice u Buchlovic		**Stupava**	
		Irrigation water	**Grass growth**	**Irrigation water**	**Grass growth**
28	*mean*	1	3	1	2
	median	1	3	1	2
	range	< 1-3	< 1-5	< 1-2	< 1-4
52	*mean*	< 1	1	< 1	< 1
	median		2		
	range		1-3		
101	*mean*	1	1	< 1	< 1
	median	***	**		
	range	< 1-2	< 1-3		
118	*mean*	1	1	< 1	< 1
	median	1	2		
	range	< 1-3	< 1-4		
138	*mean*	10	3	5	1
	median	12	4	6	2
	range	8-16	1-6	1-8	< 1-3
153	*mean*	12	3	3	2
	median	11	4	3	2
	range	4-18	1-6	1-5	1-4
180	*mean*	8	2	2	1
	median	7	3	2	1
	range	2-10	1-4	1-3	1-2

factory in which the PCB-containing product Delor had been used up to the end of 1987; the other sampling site, located near the Chřiby highlands, met the requirements put on ecological agricultural production.

Data characterising the pollution rate in the area under study in terms of imissions are shown in Fig. 1. Data on concentrations of SO_2, NO_x, CO, O_3 and fly ash indicate that the imission burden in the area under study was not extremely high. Ambient temperature and atmospheric pressure at the time of sampling were 9 °C and 1002 kPa at the site Buchlovice and 7 °C and 997 kPa at the site Stupava. It should be pointed out that the data reflect momentary situations and apply to the time of the measurement only. Measurements repeated at short intervals several times a day would be necessary to obtain actual background values.

Basic statistical parameters (mean, median, range) for PCB congeners in irrigation water and grass growth are given in Table 1. The results indicate that sum concentration did not exceed 50 $ng.l^{-1}$, which is the value laid down as the limit for drinking water. Also concentrations of the individual indicator congeners in grass growth were rather low at both the sampling sites. Concentrations below the detection limit were found for some of them.

Table 2 shows means, medians and ranges for PCB congeners in feed components intended for the nutrition of dairy cows and finishing bulls at the site Buchlovice. It can be seen that the findings were below the detection limit in some of the analysed matrices. This applied particularly for the low-chlorinated congeners (PCB 52, 101, and 118). Generally, all the concentrations were low and did not exceed background values for the Czech Republic.

Table 2
Basic statistical parameters for concentrations of PCB congeners (µg·kg^{-1} 85% dry matter) in feed components for finishing bulls and dairy cows – locality Buchlovice

PCB congeners		**Corn silage**	**Beet top silage**	**Clover**	**Alfalfa**	**Straw**	**Wheat**
28	*mean*	3	3	2	1	2	1
	median	3	2	3	2	2	1
	range	1-7	1-7	1-6	1-5	1-4	<1-2
52	*mean*	2	2	2	1	1	<1
	median	2	1	2	2	<1	<1
	range	1-4	1-4	1-3	1-3	<1-1	<1
101	*mean*	1	1	1	1		
	median	1	1	<1	<1	<1	<1
	range	<1-2	<1-3	<1-2	<1-2		
118	*mean*	1	1	1	1	1	<1
	median	1	1	1	1	<1	<1
	range	<1-1	<1-1	<1-3	<1-2	<1-1	<1-1
138	*mean*	3	4	3	2	2	2
	median	4	5	4	4	3	3
	range	2-6	3-7	1-9	2-5	1-6	1-6
153	*mean*	2	3	2	2	3	2
	median	3	3	2	3	3	2
	range	2-6	2-4	1-4	1-5	2-8	1-4
180	*mean*	2	2	1	1	1	1
	median	2	2	2	1	2	1
	range	1-5	<1-6	1-4	1-3	<1-5	<1-1

Tables 3 and 4 show basic statistical parameters for PCB congeners found in animal tissues and milk at the site Buchlovice. The data indicate that, like in the environmental samples, the concentrations did not differ from background values for the Czech Republic. Those of some congeners, particularly 101 and 118, were undetectable**.**

Fig. 2 shows mean PCB congener concentrations in feed components harvested within the site Buchlovice. The highest concentration were found for the PCB congeners 153, 138, 180, and, like in Slovakia, 28. The findings can be attributed to secondary contamination from the ecosystem components. The concentrations of PCB congeners were rather low and it can be concluded that feed components produced at this site were free of excessive amounts of PCB.

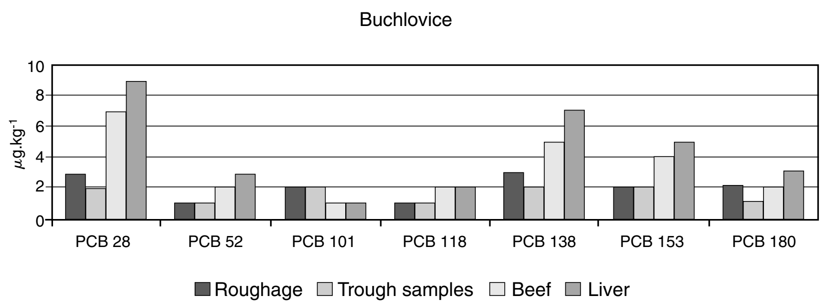

Fig. 2. Mean concentrations of PCB indicator congeners in feeds (85 % dry mass) and animal tissues – finishing bulls (fat)

Table 3
Basic statistical parameters for concentrations of PCB congeners ($\mu g \cdot kg^{-1}$ 85% dry matter) in roughage, trough samples, tissues of finishing bulls – locality Buchlovice

PCB congeners		**Roughage**	**Trough samples**	**Beef**	**Liver**
28	*mean*	3	2	4	6
	median	3	3	5	7
	range	2-7	2-6	3-9	3-11
52	*mean*	1	1	2	3
	median	1	1	3	3
	range	1-2	1-3	1-8	2-9
101	*mean*	2	2	1	1
	median	2	1	1	1
	range	1-3	<1-4	<1-1	<1-2
118	*mean*	1	1	1	2
	median	2	1	2	2
	range	<1-3	<1-1	1-3	1-3
138	*mean*	4	3	5	8
	median	5	5	5	9
	range	1-10	2-9	3-10	2-14
153	*mean*	3	3	4	9
	median	4	4	5	8
	range	2 -7	2-8	4 -10	3-13
180	*mean*	2	2	2	3
	median	2	2	3	3
	range	<1-4	1-4	1-6	1-6

Fig. 3 shows mean PCB congener concentrations in feed for and tissues and milk of dairy cows in the site Buchlovice. Again, the highest values were obtained for the congeners 28, 138, 153, and 180. The highest mean concentrations were found in liver samples. Safety limits were not exceeded in any of the analysed matrices and the concentrations were at the level of values commonly found in the Czech Republic.

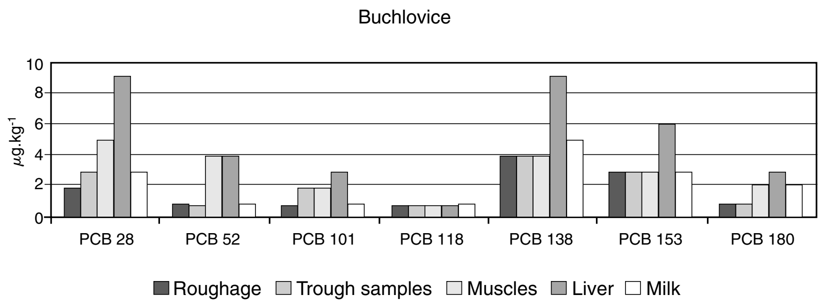

Fig. 3. Mean concentrations of PCB indicators congeners in feeds (85 % dry mass) and animal tissues (fat) and milk – dairy cows (fat)

Table 4
Basic statistical parameters for concentrations of PCB congeners (µg·kg-1 85% dry matter) in roughage, trough samples, tissues and milk of dairy cows – locality Buchlovice

PCB congeners		Roughage	Trough samples	Beef	Liver	Milk
28	*mean*	2	3	4	7	3
	median	3	2	4	8	3
	range	<1-6	1-6	1-10	3-16	1-10
52	*mean*	1	1	2	3	1
	median	1	1	3	3	1
	range	<1-1	<1-1	<1-5	1-5	<1-1
101	*mean*	1	1	1	2	1
	median	<1	1	1	1	1
	range	<1-1	<1-2	<1-1	<1-3	<1-2
118	*mean*	1	1	1	1	1
	median	1	1	1	1	1
	range	<1-3	<1-2	<1-2	<1-3	<1-2
138	*mean*	4	4	7	9	5
	median	4	5	8	10	5
	range	1-11	2-8	5-14	4-18	2-9
153	*mean*	3	3	5	9	3
	median	5	4	6	10	3
	range	1-7	2-5	2-9	4-14	1-8
180	*mean*	1	1	2	3	2
	median	2	2	3	4	2
	range	1-4	1-5	1-4	1-7	1-6

Means, medians and ranges of PCB concentrations in components of feeds intended for finishing bulls and dairy cows at the site Stupava are shown in Table 5. Concentrations bellow the detection limit were found in all the analysed matrices for PCB 101 and 118, in alfalfa and wheat for PCB 28 and 52, and in all the analysed matrices except for silages for

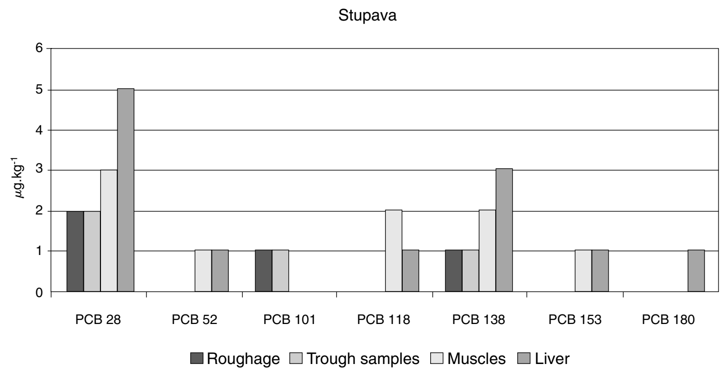

Fig. 4. Mean concentrations of PCB indicator congeners in feeds (85 % dry mass) and animal tissues – finishing bulls (fat)

Table 5
Basic statistical parameters for concentrations of PCB congeners (μg·kg^{-1} 85% dry matter) in feed components for finishing bulls and dairy cows – locality Stupava

PCB congeners		Corn silage	Beet top silage	Clover	Alfalfa	Straw	Wheat
28	*mean*	1	2	1		1	
	median	1	1	2	<1	1	<1
	range	<1-2	1-4	<1-5		<1-3	
52	*mean*	1	1	1		1	
	median	1	2	1	<1	2	<1
	range	<1-2	1-4	1-2		<1-3	
101	*mean*						
	median	<1	<1	<1	<1	<1	<1
	range						
118	*mean*						
	median	<1	<1	<1	<1	<1	<1
	range						
138	*mean*	1	2	1	1	1	1
	median	2	3	2	2	1	1
	range	1-4	1-9	1-5	1-3	1-2	1-2
153	*mean*	2	1	1	1	1	1
	median	3	2	2	2	1	2
	range	1-8	1-7	1-5	1-7	1-4	1-4
180	*mean*	1	1				
	median	1	1	<1	<1	<1	<1
	range	1-3	1-2				

PCB 180. It can be concluded from the data that the contamination of the components was too low to influence noticeably the concentrations of the congeners under study in rations for finishing bulls and dairy cows.

Basic statistic parameters for PCB congeners found in finishing bulls and dairy cows at the site Stupava are shows in Tables 6 and 7. Many findings, particularly in roughage and trough samples of feed, were below the detection limit. The concentrations did not exceed 10 μg·kg^{-1} in any of the materials and feeding of low-contaminated feed did not result in an increase of PCB concentrations in tissues.

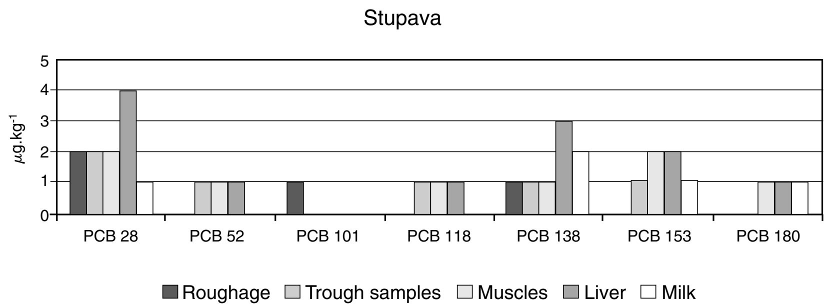

Fig. 5. Mean concentrations of PCB indicators congeners in feeds (85 % dry mass) and animal tissues (fat) and milk – dairy cows (fat)

Table 6
Basic statistical parameters for concentrations of PCB congeners (µg·kg⁻¹ 85% dry matter) in roughage, trough samples, tissues of finishing bulls – locality Stupava

PCB congeners		Roughage	Trough samples	Beef	Liver
28	*mean*	2	2	3	5
	median	2	3	4	4
	range	1-4	1-5	1-7	1-7
52	*mean*	<1	<1	1	1
	median			2	1
	range			<1-5	<1-3
101	*mean*	<1	<1	<1	<1
	median				
	range				
118	*mean*	<1	<1	1	1
	median			1	1
	range			1-4	1-3
138	*mean*	1	1	1	3
	median	2	2	2	4
	range	1-4	<1-6	<1-5	1-7
153	*mean*	1	1	2	2
	median	2	2	1	2
	range	1-5	1-3	1-4	1-4
180	*mean*	<1	<1	1	1
	median			1	2
	range			1-3	1-3

Fig. 4 shows mean PCB congener concentrations in feeds for and tissues of finishing bulls reared in the ecosytem Stupava. Like at the site Buchlovice, the highest concentrations were found for PCB 28 and 138. The former were probably due to secondary contamination from the ecosystem. The remaining values were very low and did not reach background values for the Czech Republic in many cases.

Mean PCB congener concentrations found in the ration for and tissues and milk of dairy cows at the site Stupava are given in Fig. 5. Even here, the concentrations were very low and generally lower than at the site Buchlovice. Like in the preceding figures, the highest concentrations were found for the congeners PCB 28, 138, and 153. The safety limits were not exceeded in any of the analysed matrices. Because of existing industrial production in the region, ecosystem in the sampling sites was under long-term load of both commercial mixtures (Delor 103 and Delor 106). Taking into account this fact one can explain observed

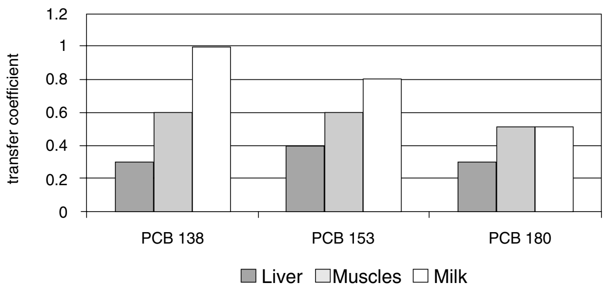

Fig. 6. Transfer coefficient Q of indicator congeners for dairy cows

Table 7
Basic statistical parameters for concentrations of PCB congeners (μg·kg^{-1} 85 % dry matler) in roughage, trough samples, tissues and milk of dairy cows – locality Stupava

PCB		Roughage	Trough samples	Beef	Liver	Milk
28	*mean*	2	2	2	4	1
	median	1	1	2	3	1
	range	<1-4	<1-4	1-5	1-7	<1-3
52	*mean*	1		1	1	
	median	1	<1	1	1	<1
	range	1-3		<1-2	<1-3	
101	*mean*					
	median	<1	<1	<1	<1	<1
	range					
118	*mean*			1	1	
	median	<1	<1	1	2	<1
	range			1-4	1-3	
138	*mean*	1	1	4	3	2
	median	2	2	4	4	3
	range	1-5	1-3	1-9	1-8	1-7
153	*mean*	1	1	2	2	1
	median	2	2	2	3	2
	range	1-4	1-4	1-7	1-8	1-7
180	*mean*			2	3	2
	median	<1	<1	1	2	1
	range			1-4	1-4	1-3

concentration of indicators congeners which are part of both mixtures. C i b e r e j et al. (1999) have published similar findings.

The most effective method for the assessment of transfer of xenobiotics from feeds into animal tissues is the calculation of the transfer coefficient Q. The method is particularly suitable for the assessment of organic pollutant burden in cattle in which the ration contains a high proportion of locally grown roughage. Published data indicate that calculation of the transfer coefficient Q allows the assessment of transfer of pollutants from feeds into animal tissues. Values Q > 0.1 are indicative of significant passage from feeds into animal tissues and identify the feed as the most probable source of xenobiotics present in animal tissues. Only data from the more polluted sampling site were used for the assessment, because values near the analytical limit would introduce a serious numerical error into the calculation.

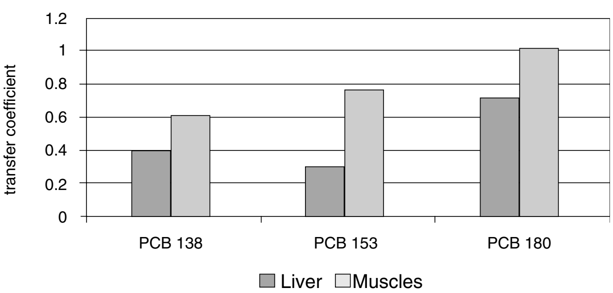

Fig. 7. Transfer coefficient Q of indicator congeners for bulls

This applies particularly to indicator PCB congeners which were found at concentrations below the analytical limit not only in irrigation water and grass growth, but also in plant products, above all in straw and wheat at the sampling site Buchlovice and in several other feed components at the site Stupava.

Since many of the findings were below the detection limit, the transfer coefficient Q was calculated only for data obtained at the site Buchlovice. Fig. 6 shows Q coefficients for dairy cows calculated using results of analyses of trough samples of feed. It is evident that all the analytes, except for PCB 118, passed from feed into hepatic and muscular tissues and milk. In spite of the low concentrations, feed can be regarded as one of the identified contamination sources and must be included among other possible sources in any comprehensive assessment. The Q coefficient for finishing bulls is shown in Fig. 7. Again, the passage of PCB congeners from feeds into animal tissues was demonstrated and feeds were identified as one of the possible contamination sources.

Similar results were obtained in fattening bulls in which $Q \leq 0.1$ only for PCB congeners 101 and 180 were found. These results are significant if we assume that the indicator PCB congeners are released stepwise from depot fat tissues. Calculations dealing with comparable ecosystem were not found in the available literature.

It can be concluded that the concentrations of organic pollutants were below the hygienic limit in most samples of animal tissues and milk analysed within our study. It must be pointed out, however, that monitoring of the transfer coefficient Q is necessary even in such situations, because accumulation of a larger number of various xenobiotics can affect not only hygienic quality, but also safety of foods.

In the food chain dynamics of contaminants was assessed using results of analyses for indicator PCB congeners of compound rations for dairy cows and fattening bulls, irrigation water and grass growth which constitutes a part of rations consumed by farm and, above all, wild animals. The latter are also used in ecosystems as biological indicators of plant origin.

Values of the transfer coefficient Q were used to assess the dynamics of transfer of the analytes under study from feeds into animal tissues. The transfer was apparent particularly in organic pollutants. Transfer studies are necessary for the assessment of public health hazards because their results can justify measures aimed at minimisation of xenobiotic burden in the food chain.

Odraz znečištění agrárního ekosystému na kontaminaci objemných krmiv v něm produkovaných

Byla sledována kontaminace součástí krmné dávky a objemových krmiv zkrmovaných dojnicím a býčkům ve dvou různých zemědělských ekosystémech v okrese Uherské Hradiště (lokality Buchlovice a Stupava). Zatímco pro Buchlovice je charakteristická intenzívní zemědělská produkce, Stupava je situována v ochranném pásmu vodní nádrže Koryčany. V části této oblasti je realizováno ekologické zemědělství. Materiály zvolené pro analýzy zahrnovaly závlahovou vodu, travní porost, senáž, pšenici, objemová krmiva, konzervovanou píci a žlabové vzorky krmiva. Byly rovněž shromažďovány vzorky vojtěšky a jetele jako součásti krmné dávky a rostlinné bioindikátory. Pro každý typ vzorků bylo v každé oblasti odebráno 15 vzorků. Navíc byly analyzovány vzorky mléka, jater a svaloviny (*m. longissimus dorsi*), vždy 10 vzorků každého živočišného materiálu. Imise byly měřeny v mobilní laboratoři Krajské hygienické stanice Brno, která umožňovala stanovení SO_2, NO_x, CO, O_3 a polétavého prachu. Ve vzorcích byly metodou vysokorozlišující plynové chromatografie s detektorem elektronového záchytu stanovovány polychlorované bifenyly (PCB). PCB byly stanovovány rovněž v mléce dojnic a v mase býčků. V žádné ze sledovaných oblastí nepřekročily nalezené koncentrace indikátorových kongenerů PCB hygienické bezpečnostní limity (průměrné koncentrace PCB v krmivu byly v rozmezí 1-2 $mg \cdot kg^{-1}$, průměrné koncentrace PCB ve tkáních zvířat byly v rozmezí 2-9 $mg \cdot kg^{-1}$).

Vypočtené koeficienty přenosu Q (pro dojnice 0,2-1,0; pro býčky 0,3-1,0) se ukázaly jako vhodný nástroj pro posouzení přestupu residuí. Bylo prokázáno, že krmivo je důležitým zdrojem kontaminace živočišných tkání a mléka.

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