PCBs in earthworms (*Eisenia foetida*) from household composts

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Introduction

Composting of organic waste has been encouraged in Sweden the last few years and many households use earthworms in this process. PCBs are found in many types of environmental samples and enter the surroundings e.g. via disposal of old paints and old copy papers contaminated with PCBs. Hydrophobic organic compounds from the compost are accumulated in the earthworm through passive absorption and via the gut [1]. The accumulation depends on properties of the compost [2] and its concentrations. Although several investigations have analysed PCB in earthworm, only a few have presented isomer specific concentrations [3]. In this study 60/80 PCB-congeners have been analysed in earthworms from three indoor household composts. Tetrachlorinated isomers dominated the profile and the highest concentrations found were of some tetraCBs. For example, the PCB # 66 were present in the range 1.9 -28.1 ng/g wet weight in the worms from the composts.

Method

Earthworms, *Eisenia foetida*, were collected from three different composts. Ten grams of worms from each compost were divided into three sub samples. 150-200 g compost material was taken from the composts A, B and C. The A-compost has been used by the personals in a smaller workplace and the B- and C-composts belonged to one-person households. The compost samples were gently dried in air for two days to 78-90 % dryness and homogenised.

The guts were emptied by keeping the worms on wet filter paper for 48 hours [4] before homogenisation with activated sodiumsulfate in a mortar. Lipids were extracted with acetone/n-hexane and n-hexane/dietylether and gravimetrically measured. Three to five gram dried and homogenised compost material was Soxhlet extracted for 24 hours with toluene. The extracts were purified by dialysis through a polyeten film into cyclopentane [5]. The clean up of the samples was continued using a 1.2 % water deactivated Florisil column from which the analytes were extracted with n-hexane and methylenchloride [6]. Forty µL tetradecane was used as keeper.

Two ^{13}C-labelled compounds were used as internal standard, PCB #80 and #153, and was added prior to extraction. ^{13}C-labelled PCB #101 was used as a recovery standard and was added just before GC-injection. Analysis was performed using single ion recording (SIR) on HRGC/LRMS. The instruments used was a Fisons MD 800 coupled to a Fisons GC 8000 using a capillary column from J&W DB-5, 60m x 32 mm i.d., 0.25 µm film thickness Folsom, CA USA. The quantification standard included eighth native PCBs and 28 pesticides. PCBs are numbered according to IUPAC.

Results and discussion

Levels of tri- to heptaCBs in three earthworm samples from each compost and the pattern in one compost were compared (Table1 and Fig. 1). The relative standard deviation for earthworms B and C is less than 20 %. One of the triplicate samples of earthworms A clearly deviates from the other two. The most abundant isomers in the earthworms are the tetrachlorinated biphenyls. These congeners constitute 33% to 63 % of the total PCB measured. PCB #28, #31, #52, #72/71/41/64, #76/70, #66, #88/95 and #101 belong to those congeners dominating the patterns in the worms and the compost. The highest levels are found in the worms from compost B having more than ten times higher concentrations than the A-worms. The C-worms show concentrations of tri- and tetraCBs between the levels found in earthworms A and B, these worms have however the highest levels of some penta- and hexaCBs. The levels of heptaCBs are similar in all three earthworms A, B and C.

In this study the tetraCBs dominate levels found in the earthworms. Hebert et al [3] found higher levels of tetraCBs in earthworms (*Lumbricus sp*) while in higher animals like voles and mice, penta- and hexa-congeners were the most common. In Fig 1. the normalised pattern of the tetraCBs in earthworms are compared with the pattern of the compost. There is a clear similarity between the compost and the corresponding earthworms B, which implies that there is no obvious selective accumulation, elimination or transformation of these congeners. Larsen et al [7] demonstrated that the elimination rates in earthworm (*Lumbricus rubellus*) of tetra- to octachlorinated biphenyls did not differ and concluded that metabolism in earthworm is not important. The concentrations of total PCBs in the A-earthworms are similar to those in a recent study with worms from the Niagara Peninsula [3], where PCB-levels in the food web not were considered as a problem. The B-earthworms exceed this total concentration with a factor ten, while the levels of the heptaCB #180 are similar.

Conclusions

* The patterns of tetraCBs in the compost and the corresponding worms are equal and hence there is no sign of specific uptake or elimination of these congeners in the worms
* The concentrations in the earthworms from household compost range from similar to elevated compared to earthworms from a relative uncontaminated area.

References

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Table 1. Concentrations of tri- to heptaCBs (ng/g wet weight) in earthworms from three different composts A, B and C and the relative standard deviation (RSD). Three earthworm samples from each compost have been analysed.

	Earthworms A		Earthworms B		Earthworms C	
TriCB	**Mean**	**RSD %**	**Mean**	**RSD %**	**Mean**	**RSD %**
# 15/18	0.28	87	1.84	6	1.18	28
# 17	0.14	36	0.94	25	0.44	44
# 27	nd		0.58	*	nd	
# 16/32	0.45	49	3.27	10	1.49	5
# 26	0.22	39	2.35	17	1.03	13
# 25	0.12	63	1.03	28	0.47	44
# 28	1.85	18	20.4	18	10.5	7
# 31	1.73	20	16.3	11	7.81	6
# 33	0.76	65	6.81	16	2.45	9
# 22	nd		8.35	13	2.81	9
Sum TriCB	5.25	35	61.52	13	28.03	5
TetraCB						
# 53	0.14	23	1.64	10	0.44	14
# 51	0.06	*	0.60	14	0.20	8
# 45	0.12	*	1.13	5	0.22	13
# 52	1.68	11	22.2	9	10.0	8
# 49	0.91	7	14.5	9	3.10	6
# 47/48	0.72	32	9.89	8	2.44	8
# 44	0.83	38	15.5	11	2.27	7
# 42	0.29	17	5.26	12	1.04	11
# 72/71/41/64	1.15	29	24.4	11	4.20	7
# 74	0.96	16	18.5	10	3.99	9
# 76/70	1.60	49	20.1	12	3.86	6
# 66	1.90	17	28.1	12	7.22	6
# 60/56	0.96	58	18.5	10	3.38	11
Sum TetraCB	10.56	16	180.35	10	42.35	7
PentaCB						
# 88/95	0.47	44	5.69	11	11.8	7
# 91	0.09	13	0.84	8	0.30	4
# 84/89/92	0.09	41	1.23	9	2.15	7
# 101	0.64	36	7.92	9	14.6	5
# 99/113	0.17	18	2.21	9	0.83	8
# 97	0.10	45	1.28	12	0.61	9
# 85	0.08	41	0.83	9	0.14	3
# 110	0.56	43	6.17	9	4.90	13
# 123	nd		0.40	18	nd	
# 118	0.60	21	4.64	5	2.67	5
# 105/127	0.20	51	1.29	27	nd	
Sum PentaCB	2.91	38	32.51	9	37.94	6

	Earthworms A		Earthworms B		Earthworms C	
HexaCB	**Mean**	**RSD %**	**Mean**	**RSD %**	**Mean**	**RSD %**
# 151	0.20	34	1.26	8	3.71	5
# 144/135	0.10	30	0.46	13	0.95	8
# 149	0.56	42	3.23	8	4.77	6
# 143/134	nd		0.11	*	0.18	5
# 146	0.35	19	0.95	3	0.73	5
# 153/132	0.63	37	2.38	1	4.56	4
# 168	0.28	14	0.95	11	1.52	5
# 141	0.40	14	0.41	8	0.35	*
# 138/160/164/16	0.82	44	3.05	7	1.81	11
# 158	nd		0.43	52	nd	
# 128	nd		0.61	9	nd	
Sum HexaCB	3.21	24	13.93	6	18.49	3
HeptaCB						
# 179	0.07	59	0.20	14	0.23	8
# 176	nd		0.04	30	0.06	12
# 178	0.04	49	0.06	12	nd	
# 182/187	0.30	25	0.66	4	1.07	7
# 183	0.07	82	0.14	9	0.15	*
# 185	0.03	*	0.03	*	nd	
# 174	0.16	83	0.20	13	nd	
# 177	0.10	71	0.11	12	nd	
# 171	0.04	69	0.07	20	nd	
# 192/172	0.04	60	0.05	13	0.04	*
# 180	0.28	75	0.40	13	0.38	7
# 193	0.05	41	0.09	33	0.08	26
# 191	nd		nd		nd	
# 170/190	0.33	*	0.26	31	nd	
Sum HeptaCB	1.23	72	2.28	9	1.88	8
SUM PCB	23.15	27	290.60	10	128.69	5

* Only detected in one sample

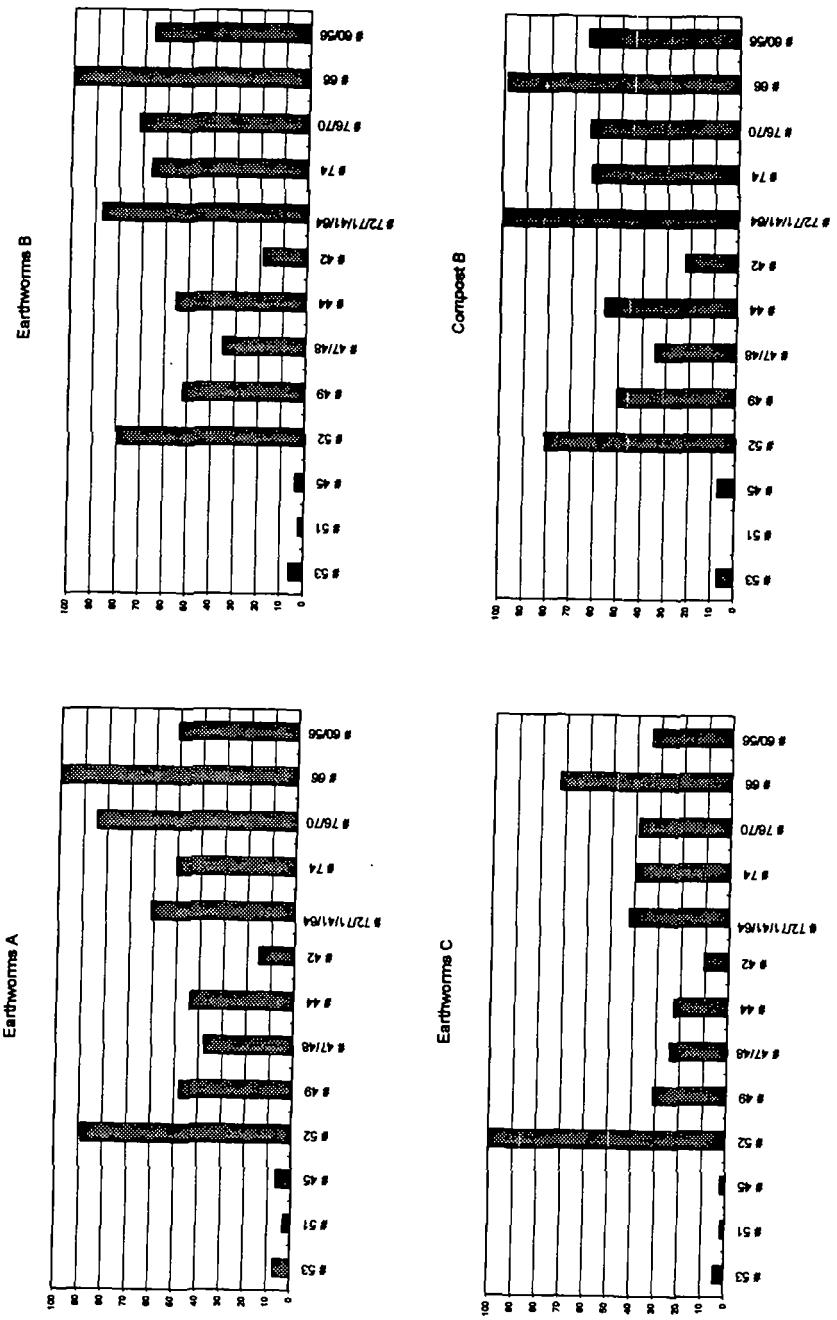

Fig. 1. The normalised tetraCB-pattern of earthworms and compost.