REF.NR.: TEND/AML/2001/07/20

HEAVY METALS AND ORGANIC COMPOUNDS FROM WASTES USED AS ORGANIC FERTILISERS

ENV.A.2./ETU/2001/0024

ANNEX 5

LIST OF HEAVY METALS IN COMPOST DERIVED FROM LITERATURE AND PERSONAL COMMUNICATION WITH EXPERTS FROM THE MST

BY

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ANNEX 5 –POTENTIAL TOXIC ELEMENTS (PTEs) IN COMPOST INVESTIGATED FROM LITERATURE AND PERSONAL COMMUNICATION WITH EXPERTS FROM THE EU(15) MEMBER STATES

Tables :

1 HEAVY METALS & ARSENIC IN COMPOSTS

Table A5- 1: Examples for the PTE concentration in BIOWASTE COMPOST

Biowaste Compost	Cd	Cr	Cu	Hg	Ni	Pb	Zn	As
	---------- *mg kg^{-1} d.m.* ----------							
Austria: Amlinger & Peyr (2001); med; n = 552 - 582	0.38	24	47	0.16	19	37	174	
Zethner et al.(2001); med [mean]; n=28	0.74 [0.72]	31 [31.3]	70 [76]	0.20 [0.22]	23 [33.3]	67.5 [73.4]	236.5 [237]	5.7
Bala (2002) Lower Austria; med [mean]; n=46	0.67 [0.7]	32.47 [32.11]	53.8 [56.5]	0.16 [0.16]	21.82 [22.27]	39.21 [41.94]	205 [219]	6.88 [7.07]
Belgium: Devliegher (2002) med; n = 195	0.82	22	45	0.15	12	69	229	
Denmark: Petersen (2001b) mean; n = 4	0.48	11	60	0.11	9.3	41	150	3.4
Finland: Vuorinnen (2002) mean; n = 3-6	0.6	-	-	0.09	9.67	30.00	-	6.00
France: Hogg et al. (2002) mean; n = 20 - 28	0.9	29	96	0.6	24	86	289	
Charonnat et al. (2001) med [mean]; n = 12-27	0.86 [1.07]	30.20 [42.81]	89.00 [109.77]	0.50 [0.63]	20.20 [25.51]	92.95 [106.05]	241.70 [325.66]	9.20 [9.05]
Germany: Reinhold (1998) med; n = 6414 - 6446	0.53	25	49	0.18	16	57	196	
ZAS (2002) mean; n = 17500	0.5	23	45	0.14	14	49	183	
Marb et al. (2001) mean; n = 19 plants	0.45	27.2	67.9	0.23	18.5	42.7	196	
Sihler & Tabasaran (1993) mean; n = 193	0.6	32	40	0.2	20	60	178	
Stock et al. (2002) med; n = 60	0.46	-	42.5	0.13	-	42.5	180	4.0
Ireland: Ní Chualáin (2004) mean; n = 19	0.6	15.3	46	0.4	19	31.7	138.5	
Italy: Centemero (2002) med [mean]; n = 127	1.08 [1.38]	23.1 [33.1]	74.9 [89.1]	-	26.2 [26.3]	70.7 [84.4]	180 [219]	
Luxembourg: Mathieu (2002) mean; n = 175 (2 plants)	0.41	32.0	38.6	0.12	15.8	48.7	218.6	7.2 (n=88)
Netherlands: Hogg et al. (2002) med n = ?	0.3	17	29	0.12	7	57	157	
Driessen & Roos (1996) mean; n = 4	0.47	16	27	0.13	10	78	204	3.8

Biowaste Compost		**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**	**As**
		---------- *mg kg^{-1} d.m.* ----------							
	Brethouwer (2002) mean; n = 811	0.52	20.82	36.41	0.14	10.79	63.42	189.48	3.76
	Koopmans (1997) mean: n = 172	0.4	14	30	0.13	8	56	159	5
Spain	Giró. (2002)	< 1.5	27	88	0.2	23	56	202	
Catalunya	med [mean]; n = 32-56	< 1.1	32	95	0.3	31	64	214	
Sweden:	Lundeberg (1998) mean; n = 5 plants	0.37	9.7	48	0.08	5.8	17	157	-
	Lundeberg (2002) mean; n = 5	0.33	9.7	27	0.05	7.9	18	93.7	-
UK:	Hogg et al. (2002) med: n=60	0.51	16	50	0.20	18	102	186	
	Bywater (1998) mean: n = 6	0.55	20.3	84.3	0.16	25.4	79.9	185	-
	Walker (1997) mean; n = 4-15	1.0	49	47	-	-	87	290	
Norway:	Lystad. (2002) med [mean]; n= 12	0.54 [0.66]	25.5 [24.3]	69 [78]	0.11 [0.22]	11.25 [11.11]	23.9 [44.56]	264 [331]	
	Paulsrud. Nedland. et al.(1997) med [mean]; n= 9 plants	0.32 [0.36]	14 [15]	52 [53]	0.07 [0.11]	10 [10]	20 [24]	197 [210]	
Switzerland:	Golder (1998) med [mean]; n = 88-137	0.36 [0.39]	22.78 [24.45]	47.00 [56.08]	0.12 [0.17]	15.10 [16.95]	44.50 [48.06]	162.0 [173.9]	-
	Candinas et al. (1999) mean; n= ?	0.36	22.3	57.7	0.128	16.3	49.3	183.5	-
		75th Percentile							
Austria:	n = 552 - 582	0.51	31.0	60.8	0.29	25.7	49.0	210.5	
United Kingdom:	n=60	0.81	20.4	72.4	0.20	22.3	130.0	225.8	
Switzerland:	Golder (1998) n = 88-137	0.45	27.88	58.18	0.20	19.33	59.38	190	-
		90th Percentile							
Austria:	n = 552 - 582	0.70	40.8	74.0	0.35	33.0	69.1	253.9	
United Kingdom:	n=60	1.09	31.4	90.5	0.40	29.2	159.4	321.6	
WD 2nd draft	**class 1**	**0.7**	**100**	**100**	**0.5**	**50**	**100**	**200**	
WD 2nd draft	**class 2**	**1.5**	**150**	**150**	**1**	**75**	**150**	**400**	
Organic farming EU-Reg. 2092/91 EEC		0.7	70	70	0.4	25	45	200	
EU Eco-label		1.0	140	100	1.0	50	100	300	

Table A5- 2: Examples for PTE concentration in GREEN COMPOST

Green Waste Compost	Cd	Cr	Cu	Hg	Ni	Pb	Zn	As
	mg kg^{-1} d.m.							
Austria: Amlinger (2000) med; n = 33	0.47	26	35	0.12	22	34	164	
Zethner et al.(2001); med [mean]; n=14	0.71 [0.69]	24 [31.9]	46 [104]	0.20 [0.25]	19.0 [25]	58.0 [81.3]	236.5 [302]	
Belgium: Devliegher (2002) med; n = 229	0.70	17	32	0.12	9	44	169	
Denmark: Petersen (2001b) mean; n = 10	0.34	8.8	28	0.07	5.7	23	140	2.8
Finland: Vuorinnen (2002) mean; n = 5	0.3	-	-	0.06	11.4	7.14	-	1.82
France: Hogg et al. (2002) mean; n = 336	1.4	46	51	0.5	22	87	186	
Charonnat et al. (2001) med [mean]; n = 22-123	0.8 [1.37]	34.16 [45.60]	43.75 [50.78]	0.30 [0.52]	18.54 [22.41]	63.00 [87.33]	170.00 [186.45]	7.32 [8.94]
Germany: Marb et al. (2001) mean; n = 5 plants	0.33	26.6	39.6	0.12	18.5	25.6	126	-
Sihler & Tabasaran (1993); mean; n = 5	0.6	23	32	-	17	45	103	
Fricke & Vogtmann (1993) mean; n = ?	0.70	27.04	32.67	0.27	17.53	60.8	167.82	
Breuer et al. (1997) med; n = 82-86	0.28	28.9	36.7	0.118	13.1	31.0	141	4.61
Stock et al. (2002) med; n = 12	0.71	-	42.0	0.16	-	56.0	205	5.4
Ireland: Ní Chualáin (2004) mean; n = 4	0.9	31.7	67.3	0.1	38.5	91.8	257.5	
Italy: Centemero (2002) med [mean]; n = 70	0.95 [0.88]	33.4 [43.4]	62.7 [71.1]	-	23.1 [29.9]	71.7 [83.2]	165.8 [181.5]	[4.5] (n=41)
Luxembourg: Mathieu (2002) mean; n = 57 (2 plants)	0.34	23.7	32.4	0.13	12.8	44.5	164.1	6.1 (n=43)
Netherlands: Hogg et al. (2002) med; n = ?	–	19	28	0.1	9	49	134	
(Driessen & Roos. 1996) mean; n = 4	0.62	25	28	0.092	14	41	144	5.1
Sweden: (Lundeberg. 1998) mean; n = 6 plants	0.48	13	41	0.06	7.3	25	168	-
UK: Bywater (1998) mean: n = 29	0.67	20.9	51.1	0.17	18.7	118.2	198	-

Green Waste Compost	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**	**As**
	---------- *mg kg^{-1} d.m.* ----------							
Walker (1997) mean: n = ?? 4-15	0.075	20	37	-	-	87	214	
Switzerland: Anonymous (2001) med [mean]; n = 74	0.33 [0.33]	21.53 [22.1]	41.63 [44.49]	0.1 [0.1]	14.46 [14.48]	33.48 [35.93]	125.05 [127.96]	
WD 2nd draft class 1	**0.7**	**100**	**100**	**0.5**	**50**	**100**	**200**	
WD 2nd draft class 2	**1.5**	**150**	**150**	**1**	**75**	**150**	**400**	
Organic farming EU-Reg. 2092/91 EEC	0.7	70	70	0.4	25	45	200	
EU Eco-label	1.0	140	100	1.0	50	100	300	

Table A5- 3: Examples for the PTE concentration in MSW-composts

MSW Compost		Cd	Cr	Cu	Hg	Ni	Pb	Zn	As
		mg kg^{-1} d.m.							
Austria:	Lechner (1989) mean; n = 32	5.0	98	333	-	80	728	1,450	
	Amlinger et al. (1990) mean; n = 25	3.3	85	455	2.5	71	461	1,187	
	Amlinger (2000) med; n = 9	2.7	209	247	1.3	149	224	769	
France:	Hogg et al. (2002) mean; n = 100	4.5	122	162	1.6	60	319	542	
	Charonnat et al. (2001) med [mean]; n = 9-56	1.66 [4.62]	109.82 [126.34]	153.00 [164.37]	1.50 [1.64]	44.35 [60.35]	313.75 [325.92]	559.50 [554.28]	- [12.69]
Germany:	Ulken (1987) mean; n = 128	3.0	164	330	2.3	87.6	588	915	
	LAGA (1985) mean; n = ?	5.5	71	274	2.4	45	513	1,570	
Ireland:	Ní Chualáin (2004) mean; n = 6	2.5	106	454	0.4	102	274	775	
Italy:	Centemero (2002) med [mean]; n = 14	2.90 [2.80]	72.7 [78.9]	114.0 [177.8]	- -	35.8 [41.8]	385.0 [365.7]	703 [1,025]	
***Portugal*:**	Russo (2002) means and range; n = 4 plants	2- <5	28- <100	157-522	-	<30-61	181-720	308-780	
Spain:	Canet et al. (2000) mean; n = 49-68	1.66	198	400	1.5	61	326	820	
	Giró Fontanals (1998) means of 2 plants	1	66 / 71	144 / 336	-	73 / 104	185 / 213	283 / 533	
Catalunya	Giró (2002) med [mean]; n = 3-207	3 4.1	80 109	217 431	1 1	65 71	428 636	454 647	
UK:	Andersen. (2002) mean; n = 18 (1 plant)	0.265	9.74	58.15	0.105	21.28	121.0	199.2	
	Walker (1997) mean: n = 4-15	5.5	71	274	-	-	513	1,510	
WD 2nd draft		**5.0**	**600**	**600**	**5.0**	**150**	**500**	**1,500**	

Table A5- 4: Examples for heavy metal concentration in Compost of/with animal manure

Compost of/with animal manure		Cd	Cr	Cu	Hg	Ni	Pb	Zn	As
		mg kg^{-1} d.m.							
Finland:	Vuorinnen (2002) mean; n = 6-8	0.83	-	-	0.085	4.00	4.83	-	1.5
France:	Charonnat et al. (2001) med [mean]; n = 10-23	1.05 [1.00]	47.60 [53.52]	215.40 [249.50]	0.10 [0.20]	38.35 [34.74]	19.50 [45.17]	600 [626]	4.40 [5.49]
Italy:	Centemero (2002) med [mean]; n = 21	0.92 [1.41]	27.3 [33.9]	164.1 [177.7]	-	20.6 [22.7]	29.5 [42.2]	778 [730]	

Table A5- 5: Examples for PTE concentration in Compost of special mixtures

"Special composts"		Cd	Cr	Cu	Hg	Ni	Pb	Zn	As
		mg kg^{-1} d.m.							
Belgium:	Devliegher (2002) med; n = 9 „Humotex"	0.6	25	36	0.1	12	63	199	
France:	Charonnat et al. (2001)) med [mean]; n = 12-14 "composts de mélanges"	1.00 [1.02]	34.35 [48.44]	106.00 [114.10]	0.70 [0.64]	24.21 [28.73]	52.63 [54.08]	316.85 [361.06]	-
Germany:	Sihler & Tabasaran (1993) mean; n = 46 "mowed material from roadside"	0.9	70	65	0.3	47	142	215	
Ireland:	Ní Chualáin (2004) mean; n = 5 "composted fishwaste"	1.0	43	33.3	0.1	8.7	8.9	67.3	
Italy:	Centemero (2002) med [mean]; n = 16 "butchery-waste+greenwaste"	0.92 [0.94]	12.7 [13.4]	44.0 [47.8]	-	12.7 [16.6]	11.2 [13.9]	284 [296]	
Italy:	Centemero (2002) med [mean]; n = 61 "growing media for gardening uses (with compost)"	0.86 [1.08]	33.6 [33.7]	63.8 [60.8]	-	25.2 [27.1]	27.8 [47.5]	203 [241]	
Netherlands:	Driessen & Roos (1996) mean; n = 4 "waste of bolbs"	0.24	9.5	9.5	0.17	7.0	21	53	2.3
	Driessen & Roos (1996) mean; n = 4 "mowed material from roadside"	0.38	18	22	0.12	9.9	49	122	3.7
	Driessen & Roos (1996) mean; n = 4 "horticultural waste"	0.6	20	41	0.24	13	68	266	2.1

"Special composts"	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**	**As**
	---------- *mg kg^{-1} d.m.* ----------							
Driessen & Roos (1996) mean; n = 4 "mixture of horsemanure. straw. peat. plaster. It's the final product (substrat) of mushrooms"	0.35	12	44	0.044	9.6	19	174	0.9
Driessen & Roos (1996) mean; n = 4 "topsoil of heather (sod) natural area in the Netherlands"	0.43	4.7	8.4	0.072	7.0	42	27	2.4
UK: Bywater (1998) mean: n = 14 "MXD - composted source-segregated material of mixed or undetermined origin"	0.67	42.4	76.9	0.25	16.4	103.9	267	-
Bywater (1998) mean: n = 3 "composted commercial single-substrate matter."	0.37	5.5	31.6	17.8	0.05	5.3	117	-

2 FURTHER PTEs IN COMPOSTS

Table A5- 6: Examples for the concentration of further PTEs in composts

	Al	As	B hwl	Be	Co	Fe	Mn	Mo	Na	Sb	Se	Sn	Tl	V
	mg kg^{-1} d.m.													
Austria: Zethner et al. (2000) med [mean]; n = 15 - 42	11,541 [11,880]	5.7 [6.4]	8.2 [9.5]	0.5 [0.5]	7.2 [9.3]		643 [830]	2.2 [2.7]		1.2 [1.8]		<5 [<5]	<2.5 [<2.5]	26 [29]
Bala (2002) med [mean]; n = 65	11,794 [11,914]	6.88 [7.07]			6.55 [7.26]	14,418 [15,299]		1.97 [1.89]						25.5 [26.8]
Germany: Breuer et al. (1997) ***BWC***; med [mean]; n = 3-196	6,083 [6,485]	3.41 [3.65]	20.5 [21.5]		5.29 [5.49]	9,612 [9,811]	401 [400]		2958 [3008]		0.17 [0.17]		0.072 [0.074]	
GC; med [mean]; n = 4-86	6,194 [6,239]	4.61 [4.74]	18.5 [20.5]		6.4 [6.4]	11,358 [11,991]	487 [495]		285 [319]		0.14 [0.15]		0.099 [0.092]	
France: Charonnat et al. (2001) ***BWC***; med [mean]; n = 9-14		9.2 [9.05]				11,640 [10,350]	[430]	[1.81]			0.5 [0.78]			
GC; med [mean]; n = 15-58		7.32 [8.94]				6,600 [8,140]	262 [293]	1.6 [3.15]			0.36 [1.14]			
Italy: Becaloni et al. (o.J.) ***BWC*** *incl. agroindustrial sludges*; range of means (10 plants)		2.17 – 14.25		0.13 – 0.50							0.80 – 4.50	0.70 – 50.00	0.50 – 1.50	18.20 – 96.00
GC; range of means (3 plants)		7.60 – 12.51		0.21 – 0.31							0.8 – 1.60	1.03 – 6.00	0.88 – 1.50	21.13 – 66.50