QUALITY STANDARDS FOR URBAN WASTE FERTILIZERS: PUTTING ECOTOXICOLOGY IN THE PICTURE

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I. Introduction & Objectives

- EU **Circular Economy Package**[a]:
  - **Boost** the EU **production/movement** of fertilizing products, e.g. **urban wastes fertilizers (UWF)**
  - **harmonization** of **quality standards** (certification)
- Current **UWC quality** assessment frameworks:
  - **no information** on the **bioavailable fraction** of potential **contaminants** for organisms.
- **Objectives:**
  i) evaluate the effects of UWF applications on soil using standard ecotoxicological tests;
  ii) to develop an environmental quality certification system for UWF agricultural applications
- **Five UWF** tested: source separated organic wastes or mixed urban wastes (MUW)
- **Battery** of standardized **ecotoxicological assays** (plants+soil invertebrates+freshwater species).
- Higher ecotoxicity expected for (MUW) Fertilizers.

II. Materials & Methods

Test-Battery

Species	Endpoint	Guideline	Matrix
E. andrei	Avoidance Reproduction	ISO 17512-1 ISO 11268-2	**Soil-UWF dilutions (%UWF):** 0 0.7 2.1 6.3 18.9 56.7
F. candida	Avoidance Reproduction	ISO 17512-2 ISO 11267	
E. crypticus	Reproduction	ISO 16387	
L. sativa *T. aestivum*	Germination and Growth	ISO 11269	
C. vulgaris *R. subcapitata*	Population growth	OECD 201	UWC Eluates (1:4 w:v, 12h agitation/12 h deposition) DIN 38 414 S4, 1984
L. minor	Biomass growth	OCDE 221	
B. calyciflorus	Mortality	ASTM E1440-91	
	Population growth	ISO 20666	
D. magna	Mortality	OECD 202	
H. incongruens	Mortality	OstracodToxKit F chronic	
H. viridissima	Somatic growth		
	Mortality	Trottier et al., 1997	
	Feeding	Quinn et al., 2007	
D. rerio	Malformations	Trottier et al., 1997	

UWF Characterization

Parameter (unit)	GW[1]	FGW[1]	MUW1[1]	MUW2[1]	MUW3[1]
pH	8.3	8.1	7.2	7.8	7.1
[2]EC (mS cm/1, 25ºC)	3.1	7.4	6.64	4.3	5.17
Salinity (25ºC)	1.6	4.1	3.6	2.3	2.7
Organic Matter (%)	46.74	42.73	37.26	43.62	44.21
Total N (%)	1.51	2.87	1.65	1.63	1.89
Cd (mg/kg)	1.45*	3.03*	5.60*	3.28*	3.10*
Pb (mg/kg)	43	44	235	197	242
Cu (mg/kg)	26	41	204	184	336
Cr (mg/kg)	34	28	100	63	107
Ni (mg/kg)	19	21	67	52	34
Zn (mg/kg)	64	98	149	149	151
Hg (mg/kg)	0.06	0.06	0.37	0.61	0.37
Waste source	Green	Food and green	Organic fraction of mixed urban waste		
[3] Recommended Use	Agriculture (Horticultural crops)		Gardening, vineyards, orchards, other arboreal and shrub species		
[3] Maximum Annual doses (t/ha)	50	50	10		
Maximum Annual doses (% of UWF, dry basis) [3, 4]	3.33		0.7		

[1] GN – garden waste; FGW – food and garden waste; MUW – mixed urban waste;
[2] Electrical Conductivity, [3] DL 103/2015 [4] Assuming an average soil density of 1.5 g/ cm3 and an incorporation depth of 10 cm.
* - Above legislation limits

III. Results & Discussion

UWF increasing Toxicity *

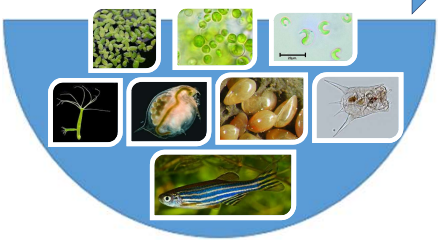
* No direct relationship with metal content, but with EC/ Salinity

FGW > MUW1 > MUW3 > MUW2 > GW

E. andrei
F. candida
E. crypticus
L. sativa
T. aestivum

FGW > GW > MUW2 > MUW1 > MUW3

D.magna
H. viridissima
D. rerio
H. incongruens
B. calyciflorus
L. minor
R. subcapitata
C. vulgaris



Organism	Endpoint	UWF toxicity (%) EC50s or % effect at 100% eluates (+)				
		FGW	GW	MUW1	MUW2	MUW3
E. andrei	Avoidance	5.55	n.d.	11.92	23.20	22.80
	Reproduction	3.8	39.5	5.27	9.84	12.22
F. candida	Avoidance	35.4	n.d.	19.1	n.d.	26.1
	Reproduction	3.98	54.68	7.28	21.78	26.65
E. crypticus	Reproduction	13.72	n.d.	12.97	28.76	26.62
L. sativa	Biomass	15.09	n.d.	36.69	42.36	n.d.
T. aestivum	Biomass	23.1	n.d.	n.d.	n.d.	n.d.
L. minor	Growth	45.1	5.25	n.e.	n.e.	n.e.
B. calyciflorus	Mortality	n.e.	17.7	16.7+	10.0+	3.3+
D. magna	Population growth	n.e.	12.5	68+	64.5+	40+
	Mortality	100+	70+	60+	100+	80+
H. incongruens	Mortality	23.3+	25.7+	3.3+	70+	16.7+
	Somatic growth	22.1+	n.d.	7.9+	31+	5.5+
H. viridissima	Mortality	61.0	23.4	71.9	18.4	50+
	Feeding	9.49	6.36	25.2	6.14	34.9
	Malformation	76.8	n.f.	26.7	8.79	33.8
D. rerio	Mortality	4+	30.7	13.6+	24+	40+

n.d. – not determined; n.e. - No Effect

IV. Conclusions & Future Work

- For **UWF applications above recommended doses toxic effects can occur** to both plants and soil fauna.
- Unexpectedly, an **UWF** from **source separated organic wastes (FGW)** showed the **highest toxicity** for both **soil** and **freshwater species,** probably **due to high salinity.**
- **Freshwater producers** were in general **less sensitive** to UWF **than** primary and secondary **consumers.**
- **Ecotoxicological assessments** should be **included** in future **UWF quality frameworks.**

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References: a) Circular Economy Package: http://ec.europa.eu/environment/circular-economy/index_en.htm); b) Decree-Law No.103/2015, of 15 June, on fertilizing materials. http://www.iniav.pt/fotos/editor2/decreto_lei_103_2015_fertilizantes.pdf