NUTRIENTS (N and P) RECOVERY OPTIMISATION THROUGH COMPOSTING PROCESS: THE REFERTIL RESULTS

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Circular approaches to phosphorus: from research to deployment

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BATs COMPOSTING TRIALS

BIOMASA GUADALQUIVIR

2 TECNOLOGIES:

- **Static**. Aerated piles with semi-permeable cover. con Cubiertas semi-permeables. ESTÁTICO
- **Dynamic**. Windrow

2 INPUT material:

- **Green**: Fruit and vegetable discards + green residues from parks
- **Brown**: cattle manure + grinded biomass

2 TREATMENTS:

- Blank
- Inoculated: with enzimatic cocktail in order to accelerate and improve the compost process



PROFIKOMP

2 TECNOLOGIES:

- **Static**. Aerated piles with semi-permeable cover. con Cubiertas semi-permeables. ESTÁTICO
- **Dynamic**. Windrow

1 INPUT material:

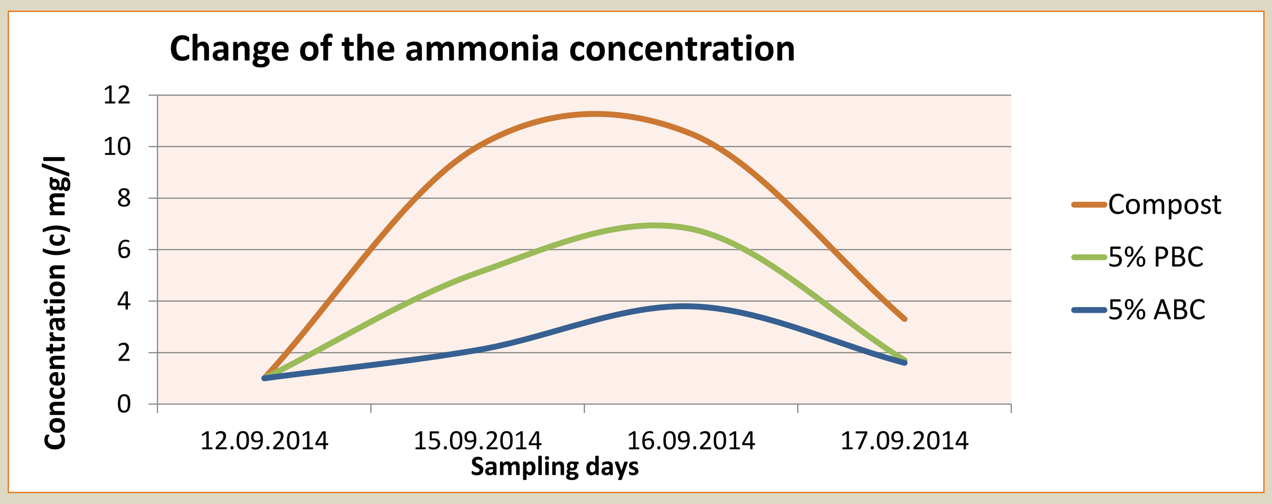
- **Green**: vegetal biomass + Biological Municipal Waste

TREATMENTS:

- Different **heap size** configurations



GAS ADSORPTION MODELING WITH PLANT BASED ACTIVATED (PBC) AND ANIMAL BONE CHAR (ABC) BASED BIOCHARS DURING INTENSIVE PHASE OF COMPOST FORMATION

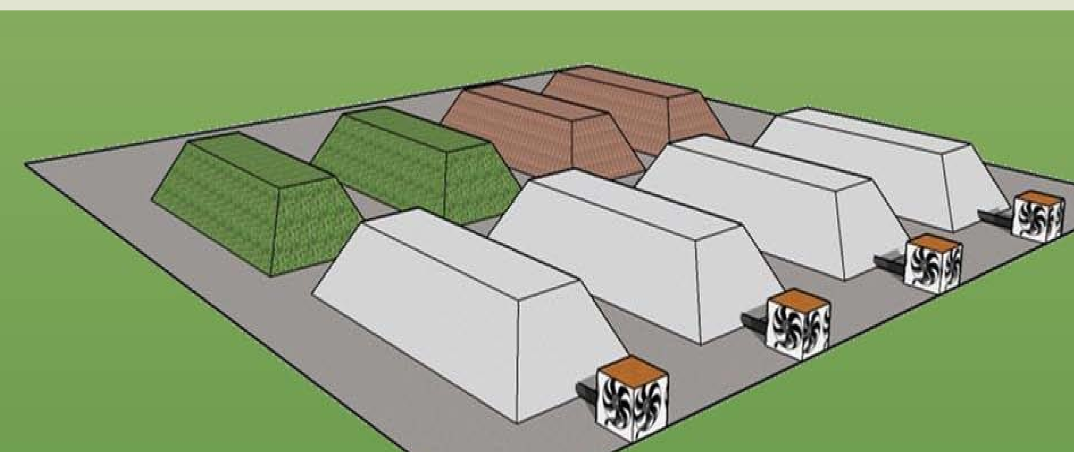


During composting process depending on the C/N ratio high volume of ammonia could be generated.
Quantity of releasing ammonia under intensive phase of composting after it has been mixed with biochars PBC and ABC
ammonia generation is significant in the initial phase/stage because of the larger surface of the animal bone based biochar has a better adsorption ability than plant based biochar

INPUT MATERIAL AND COMPOST ANALYSIS

INPUT and COMPOST Analysis		GREEN	GREEN Compost						BROWN	BROWN compost					
		Fruit and vegetable discards Green residues from parks							Cattle manure Grinded biomass						
		Input mix	TRIAL 1		TRIAL 2				Input mix	TRIAL 1		TRIAL 2			
			GS	GD	GS3 ino	GS4	GD3 ino	GD4		BS	BD	BS3 ino	BS4	BD3 ino	BD4
Physical parameters															
Bulk density (kg/m^3)		187,5	510	500	420	450	390	350	367,5	410	380	270	370	260	310
Moisture (%)		35,20	45,98	48,78	22,91	25,18	27,52	28,76	55,93	42,05	43,57	27,60	26,11	22,56	25,45
pH		6,34	8,44	8,46	8,3	8,3	8,2	8,2	7,71	8,65	8,31	8,2	8,2	8,1	8,1
C/N ratio		34,22	23,60	22,60	9,8	17,2	14,1	14,4	18,58	22,00	24,80	12,6	10,7	13,6	20,3
Organic matter (%)															
TOC		36,70	22,2	19,10	21,4	30,7	29,0	32,30	38,40	31,30	30,00	35,90	27,10	38,60	29,50
OM		63,27	38,3	32,93	36,89	52,92	50,00	55,68	66,20	53,96	68,96	61,89	46,72	66,55	50,86
Plant nutrients (%)															
Nitrogen (N) total		1,08	0,94	0,85	2,19	1,78	2,06	2,25	2,55	1,42	1,61	2,85	2,53	2,83	1,45
Phosphorus (P_2O_5)		0,15	1,59	1,56	1,29	1,35	1,32	1,27	0,46	1,99	1,50	1,43	1,30	1,47	1,14
Potassium (K_2O)		0,65	2,31	2,52	2,89	3,12	3,23	3,19	0,85	2,61	2,63	3,27	3,27	3,29	2,95
Calcium (CaO)		2,42	8,11	2,52	14,4	12,5	12,3	11,9	1,41	4,39	4,06	9,47	11,8	7,71	8,99
Magnesium (MgO)		0,22	0,65	0,80	1,24	1,25	1,31	1,23	0,34	1,12	0,86	1,44	1,38	1,29	1,27
Iron (FeO)		0,06	0,74	0,74	0,84	0,77	0,75	0,68	0,09	0,41	0,47	0,67	0,99	0,51	0,88
Sodium (Na_2O)		0,09	0,56	0,65	0,45	0,45	0,47	0,51	0,29	1,06	0,96	0,68	0,60	0,77	0,65
PTEs (ppm	**EoW**														
Cadmium	1,5	<0,3	<1,0	<1,0	<0,3	<0,3	<0,3	<0,30	<0,3	<1,0	<1,0	<0,3	1,7	<0,3	<0,3
Copper	200	7,75	17	24	32	43	30	30	7	27	24	28	33	27	26
Chromium	100	1,75	10	10	58	51	51	49	1,25	6	6	56	63	35	45
Mercury	1	0,03	0,06	0,06	0,05	0,05	0,04	0,07	0,03	<0,02	<0,02	0,03	0,08	0,03	0,03
Nickel	50	1,75	5	5	25	20	21	16	1,25	6	4	28	28	22	23
Lead	120	3,20	17	17	15	14	12	11	1,75	6	8	9	10	7	6
Zinc	600	21,50	69,0	79,0	131	105	111	101	40	161,0	128,0	180	140	176	147

TRIAL 1: two different Technologies: Static aerated piles with semi–permeable covers (**S**) and Dynamic windrow composting at open air with mechanical turning (**D**)
TRIAL 2: two different Technologies and two different Treatments: blank (**4**) and inoculated with an enzymatic cocktail (**3**) to evaluate the effect of other possible biological inoculums and the better moment for its addition to the materials in the process or final compost (bio-cocktails of species with properties of N fixation, P solubilisation, disease suppression, micorrizhae, etc).



N and P RECOVERY OPTIMAZATION: CONCLUSIONS

-**NPK** is sensibly **higher** in **inoculated compost**. In N, the reason for improvement could be in the quicker decomposition of carbonated compounds releasing C metabolites for microorganisms and make them able to microbiologically fix the N and reduce the ammonia losses
- Much **quicker composting** start up in **Static** system, due to the forced aeration and finished earlier. Delicate balance between aeration and desiccation effect
- In T2, Green inoculated compost were lower in C/N and Total Organic Carbon, showing a higher degree of stability compared to non inoculated compost. Same in Brown compost.

SIGNIFICANT IMPROVEMENT HAS BEEN REACHED IN COMPOSTING PROCESS AND IN COMPOST FINAL QUALITY IN TERMS OF N RETENTION IN COMPOST.

-PTEs (heavy metals) concentrations rise up very high from input to compost. The only suitable explanation could be the difficulty for fine grinding and extraction of the heavy metals in the input material due to its high fibre content. In compost, probably PTEs extraction is much higher and PTEs content closer to the reality of material, not the case in input, where this element are under-measured. In all the cases complies with EoW limits.

MINIMIZING N LOSSES DURING COMPOSTING

• Selection and **ADEQUACY of INPUT MATERIALS** (biowastes) suitable mixes for optimal N retention and recovery in compost. Use of green woody material in adequate proportion to reach C/N ratios over 25 at the starting of the composting process.

•To **CONTROL** the excess rise of **TEMPERATURE** during thermophillic phase associated to the rise of pH and massive ammonia volatilization.

•To guarantee adequate **HUMIDITY** during the thermophilic composting phase.

•To use sources of **EASILY AVAILABLE CARBON SOURCES** to add during thermophillic phase of composting in order to reduce the ammonification process. (for example liquid dung or silos as wetting agents).

•**Use of BATs**: “Static Aerated piles with semi-permeable cover”, compared with more traditional technologies like “Windrow composting” or “Aerated static piles”.

•Identification of the **BEST COMPOSTING PROCESS CONFIGURATION**: size and geometric definition of windrows (height at the top of the pile and sidewalls) still to be defined in different conditions.

•Use of **COMPOST COVERS, TOPSOIL OR CLAY COVERS** or additions during thermophillic phase of aerated static composting systems to absorb ammonia excess release.

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