

ADDING VALUE TO THE TWO-PHASE OLIVE-MIL WASTE (“ALPERUJO”) THROUGH COMPOSTING FOR PRODUCTION OF HUMIC FERTILIZERS AND AMENDMENTS FOR SOIL BIOREMEDIATION



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ALPERUJO

*two phase olive mill
waste
olive pomace
wet husk
sánsa umida*

The main by-product generated by the Spanish olive oil industry (4 million tons/year)

**Around 90% of mills use the two-phase centrifugation method
More than 75% of olive oil is produced by using it**



AL is a very pasty and wet lignocellulosic material, scarcely porous and very susceptible to compaction

**High moisture content
Small particle size
High lipid content**



AL is rich in OM but scarce in nutrients

AL has slightly acidic pH, unbalanced C/N ratio and potentially phytotoxic compounds (phenols)

*These unfavourable properties determined the necessity of **adding bulking agents** to improve physical structure and amend nutrient composition*

Main characteristics of raw materials (g/kg, dry weight basis): AL (n= 5); CW, cotton waste; GS, grape stalk; OL, olive leaf; FCB, fresh cow bedding; HM, horse manure; PM, poultry manure and SM, sheep manure.

PARAMETERS	AL	BULKING AGENTS						
		AGRICULTURAL WASTES			MANURES			
		CW	GS	OL	FCB	HM	PM	SM
Moisture (% f.w.)	60.4	11.5	5.9	7.3	46.1	19.5	20.1	38.5
pH	5.1	6.8	4.4	5.6	7.5	7.5	7.5	8.5
EC (dS m⁻¹)	4.4	4.1	4.2	1.7	7.5	9.3	8.5	11.3
Organic matter	929.4	933.0	934.1	906.0	664.0	578.0	805.5	456.5
Lignin	364.8	232.0	262.3	319.1	185.0	201.1	129.7	211.4
Total-N	12.7	21.3	8.0	13.3	19.4	15.3	32.3	17.7
C/N ratio	42.0	22.4	60.1	39.4	19.0	20.4	12.3	14.3
P	1.0	1.8	0.6	0.8	2.5	2.3	2.2	2.2
K	19.0	17.4	20.0	5.7	35.8	21.2	13.5	16.5
Ca	5.9	23.0	6.3	26.0	63.7	58.6	47.5	100.9
Mg	2.4	4.2	1.5	2.4	8.8	14.9	5.5	18.7

Composition and management of composting substrates.

Pile	Composition (%)		Turnings	Forced ventilation	Composting time (weeks)
	Fresh basis	Dry basis			
1	92.6 AL1 + 7.4 CW	(80/20)	1	yes	42
2	95 AL2 + 5 GS	(87/12/1)	3	yes	49
3	95 AL2 + 5 OL	(87/12/1)	3	yes	49
4 and 5	90 AL3 + 9 FCB + 1 AL compost	(87/11/2)	14	4 (no) 5 (yes)	36
6	91 AL4 + 9 HM	(85/15)	18	no	37
7	52 AL5 + 48 PM	(37/63)	7	no	38
8	65 AL5 + 35 SM	(57/43)	7	no	38

In piles 4-8, composting time was considerably shorter due to:

The greater nutrient availability of manures and their inoculum effect

The greater number of turnings which enhanced the composting process by homogenising and redistributing micro-organisms, moisture and nutrients



Visual effects of the composting process on pile 5



Main characteristics of the AL, AL compost, and manures of different origin (mean values, dry weight basis).

Parameters	AL (n=5)	AL compost (n=8)	Manures (n=10)
pH ¹	5.1	8.8	7.8
EC ¹ (dS m ⁻¹)	4.4	3.1	4.6
Organic matter (g kg ⁻¹)	929.4	804.2	756.0
Lignin (g kg ⁻¹)	364.8	402.5	167.4
Fats (g kg ⁻¹)	95.6	5.0	-
Water-soluble phenols (g kg ⁻¹)	11.2	3.1	-
Total-N (g kg ⁻¹)	12.7	22.9	31.7
NH ₄ ⁺ -N (mg kg ⁻¹)	-	130	5243
NO ₃ ⁻ -N (mg kg ⁻¹)	-	77	232
P (g kg ⁻¹)	1.0	1.9	3.2
K (g kg ⁻¹)	19.0	33.5	20.9
Ca (g kg ⁻¹)	5.9	26.7	56.4
Mg (g kg ⁻¹)	2.4	5.4	9.8
C/N ratio	42.0	18.2	12.5
GI (%)	0	81	-
DH (%)	-	75.5	-
PHA (%)	-	70.6	-

¹water extract 1:10, EC: electrical conductivity, CV: Coefficient of variation, GI: germination index, DH: [(HAC+FAC)/TEC]×100, PHA: (HAC/TEC)×100, TEC: total organic carbon extracted in 0.1M NaOH, HAC: humic-like acid carbon and FAC: fulvic-like acid carbon.

-: not determined.

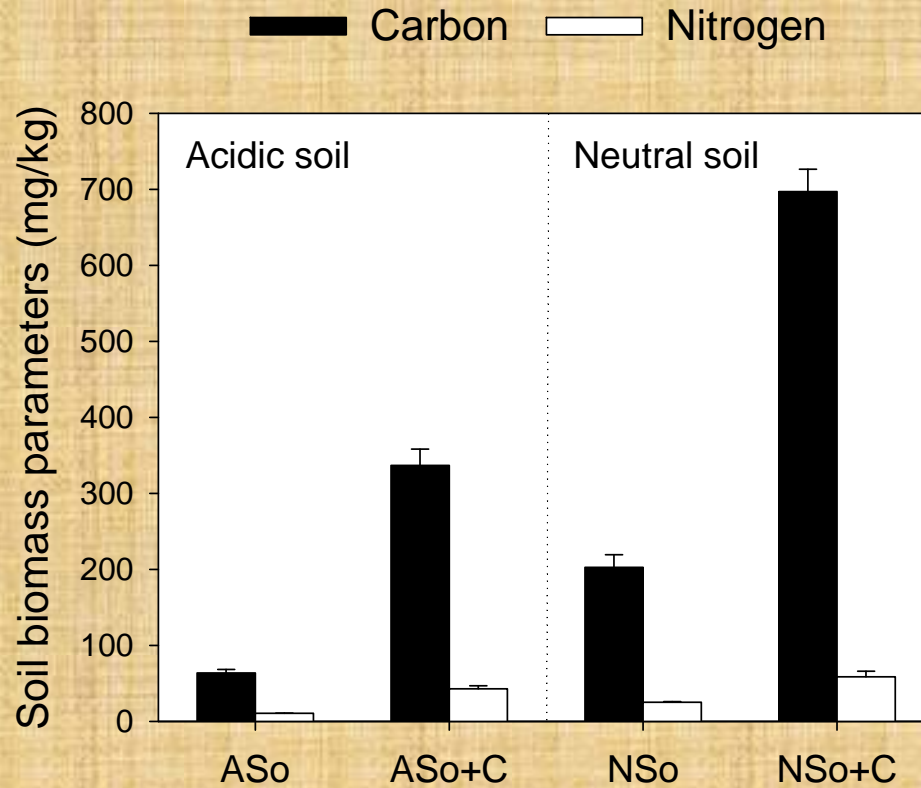
Bioremediation experiments

Two non calcareous heavy metal contaminated soils:

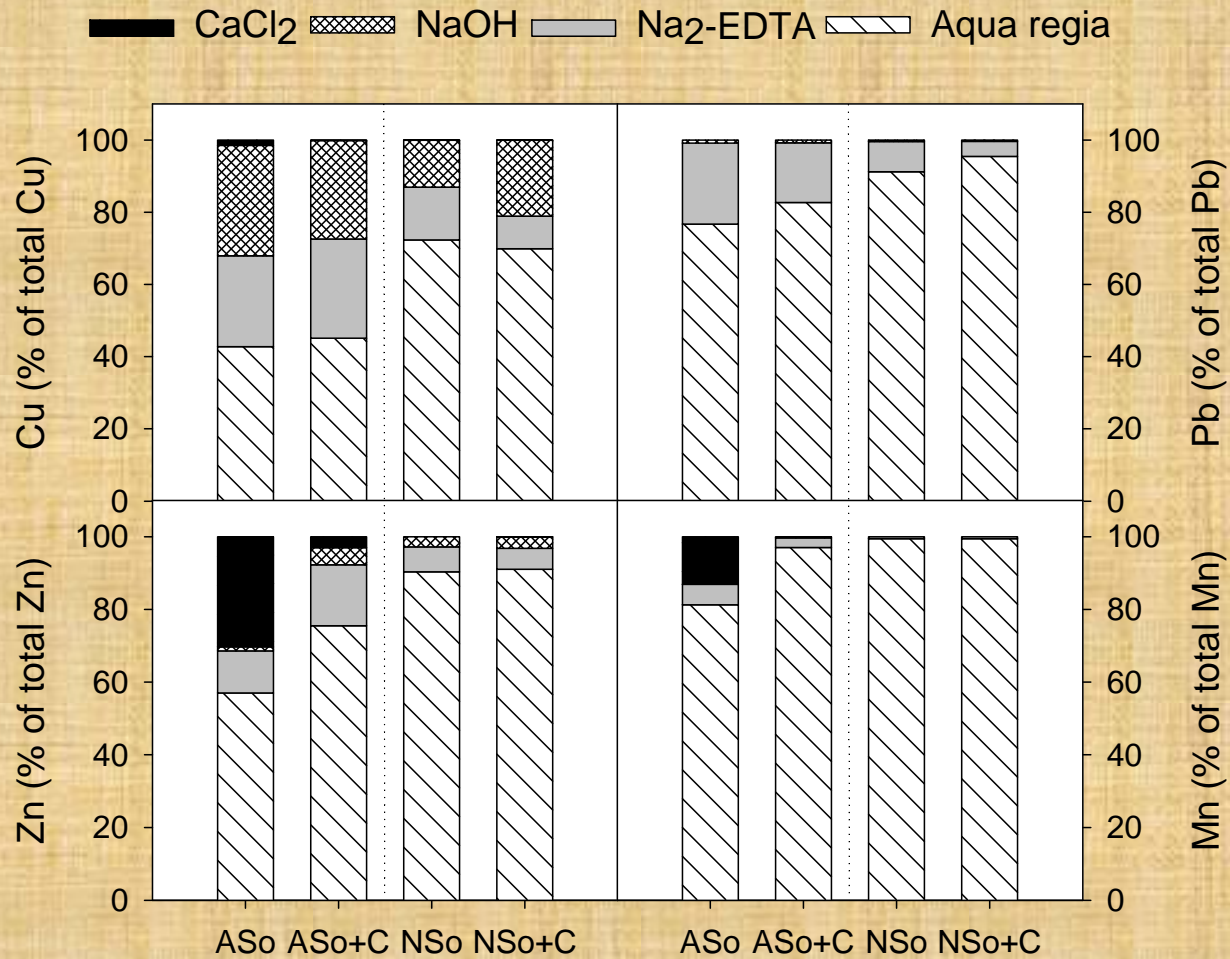
- *Acid soil (AS₀) ppm: Zn(546), Pb(373), Cu(176)
Mn(893)*
- *Neutral soil (NS₀) ppm: Zn(923), Pb(590), Cu(185),
Mn(917)*

*were amended with the compost from pile 5
(72 t/ha), later incubated (darkness) at 26 °C
during 2 months*

Microbial biomass parameters (means+SD) for each type of soil.



Soil heavy-metal fractionation by sequential extraction.



CONCLUSIONS

- Both selection of an appropriate bulking agent and mechanical turning are key factors for the proper AL composting performance. A clear reduction in the composting time was achieved when the use of manures was combined with frequent turnings.*
- The AL composts, with a clear absence of phytotoxicity, have an acceptable nutrient content and are rich in humified OM, nearly half is composed of lignin. They can be effectively used as soil organic fertilisers and amendments, even if supplementary N fertilization is required for the appropriate plant growth.*
- These composts can be considered useful for bioremediation of heavy metal contaminated soils as they improve soil fertility by stimulating microbial activity. Also, they can contribute to reduce soil pollution by their liming effect which leads to metal immobilization.*