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Soil conditioner, suitable for biological cultivation, developed from olive-oil-mill wastes using a fast microaerobic biotreatment method

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A simple and quick method, which utilizes degraded and toxic remains to produce eco-friendly soil substrate with higher added value

Environment-friendly degradation of OMW

Usual treatment and disposal practice followed in Greece – environmental impacts:

- **Neutralization with lime and disposal in evaporation ponds/lagoons**

- overflow and negative environmental effects in neighbouring systems
- Polyphenols and other organic compounds ⟶ high COD ⟶ low Dissolved Oxygen ⟶ induction of anaerobic conditions ⟶ odour nuisance

- **Direct disposal into soil, sea or rivers**

- Oil compounds ⟶ increased soil hydrophobicity and decrease water retention and infiltration rate
- Polyphenols ⟶ bactericide and phytotoxic properties cause alterations in N cycle, changes in soil microbial activity as well as contamination of surface and groundwater.
- High phosphorus contents ⟶ eutrophication
- Lipids form an impenetrable film, blocks out sunlight and oxygen ⟶ hypoxia

Conclusions

- **Greece and Mediterranean** countries lack the “active” organic substance (min **2%**), the soils are **95% below fertility level**; they are in the **“desertification” progress**.
- OMW soil conditioner can replace the more expensive and not renewable black-humus peat
- The utilization of Biofertilizers such as the proposed one is among the best solutions
- The proposed method is of **low cost** in both investment and operation
- A **toxic** waste is converted into a **soil conditioning** product
- The production time is reduced to only 2 months max compared to 7-12 months in the common procedures
- OMW soil conditioner shows a positive effect on plant growth

Biocatalytic micro-aerobic treatment of OMW

Basic point the frequent monitoring (temperature /day, microorganisms and maturation index twice/week)

Materials

- Olive mill waste waters from 3-phase mill. They may be replaced by 2-phase mill wastes.
- All plant materials that remain in olive mills before olive oil extraction. They may be replaced by other green residues.
- Biocatalyst, natural zeolite and nutrients from natural resources approved in organic farming.

Method

- Crushing plant residues < 2 cm with calculation of suitable for microbial growth nutrients.
- Addition of biocatalyst, zeolite and nutrients from natural resources if needed.
- Addition of OMW up to 60% moisture content, stacking of the composting mixture to piles.
- Mixing, aeration and wetting according to the microorganisms content (total and pathogens) and the maturation parameters.
- The end of the biotreatment is between 40-60 days. Physicochemical parameters are measurement to classify the product.

Biocatalyst ★

Innovative solid substrate based on a special organic rock, mineral origin, inoculated with soil microorganisms laboratory cultivated.

★ Patent 2004010018 (2004) Owner Dr Dinos Chassapis Ass. Professor University of Athens

Typical analysis:

- Microorganism population (Bacteria, mycetes, actinomycetes,) 2. 10^9 c.f.u./g
- Humic substances 30% (dry basis)
- Mineral content 38% (dry basis)

* Accelerates 5 times the biochemical reactions in the compost.
* Enhances the bio-oxidative phase of composting

provides necessary microorganisms for the decomposition of polyphenols, carbohydrates, lipids and other organic substances

» **Humic acids**

* Operates at wide ranges of pH
* Suitable for Mediterranean climate conditions.
* Active even in extreme environments

Natural zeolite (clinoptilolite)

Zeolite:

1. Mineral suitable for biological cultivation, neutral with high cation exchange capacity
2. Enhances surface area and porosity, facilitates the growth of the biocatalyst's microbial populations and improves the soil quality.
3. Entraps heavy metal ions in its micropores reducing their bioavailability

Basic physicochemical parameters of OMW material before and after composting

Parameter	**OMW**	**Green wastes**	**Compost Initial mixture**	**Soil conditioner (60 days)**
Moisture (%)	90.3	18.1	68.1	35.9
Electrical conductivity (mS/cm)	41	0.99	1.92	1.8
pH	5.48	6.85	5.7	7.3
Bulk density(g/ml)	0.98	0.12	0.33	0.4
Ash (% w/w)	19.8	7.3	14.0	21.9
Organic matter (% w/w)	80.2	92.7	86.0	78.1
Total organic carbon (% w/w)	45.7	53.8	49.9	45.3
Total Kjeldahl nitrogen (% w/w)	1.7	2.0	1.3	1.3
Humic acids (% w/w)	nd	1.2	2.8	8.0
Total phenols (mg/kg)	374.3	93.2	80.3	32.3

91.4% reduction of polyphenols was accomplished

Physical parameters evaluation OMW compost

Soil Medium for growing plants	Produced OMW soil conditioner	Optimum Soil Substrate
EAW (vol %) + WBC (vol%)	55	55-65
AS (vol%)	23,2	20–30
TPS (vol%)	80,7	85
Bulk density g L^{-1}	460	400

EAW: easily available water
AS: air space
WBC: water buffering capacity
TPS: total pore space

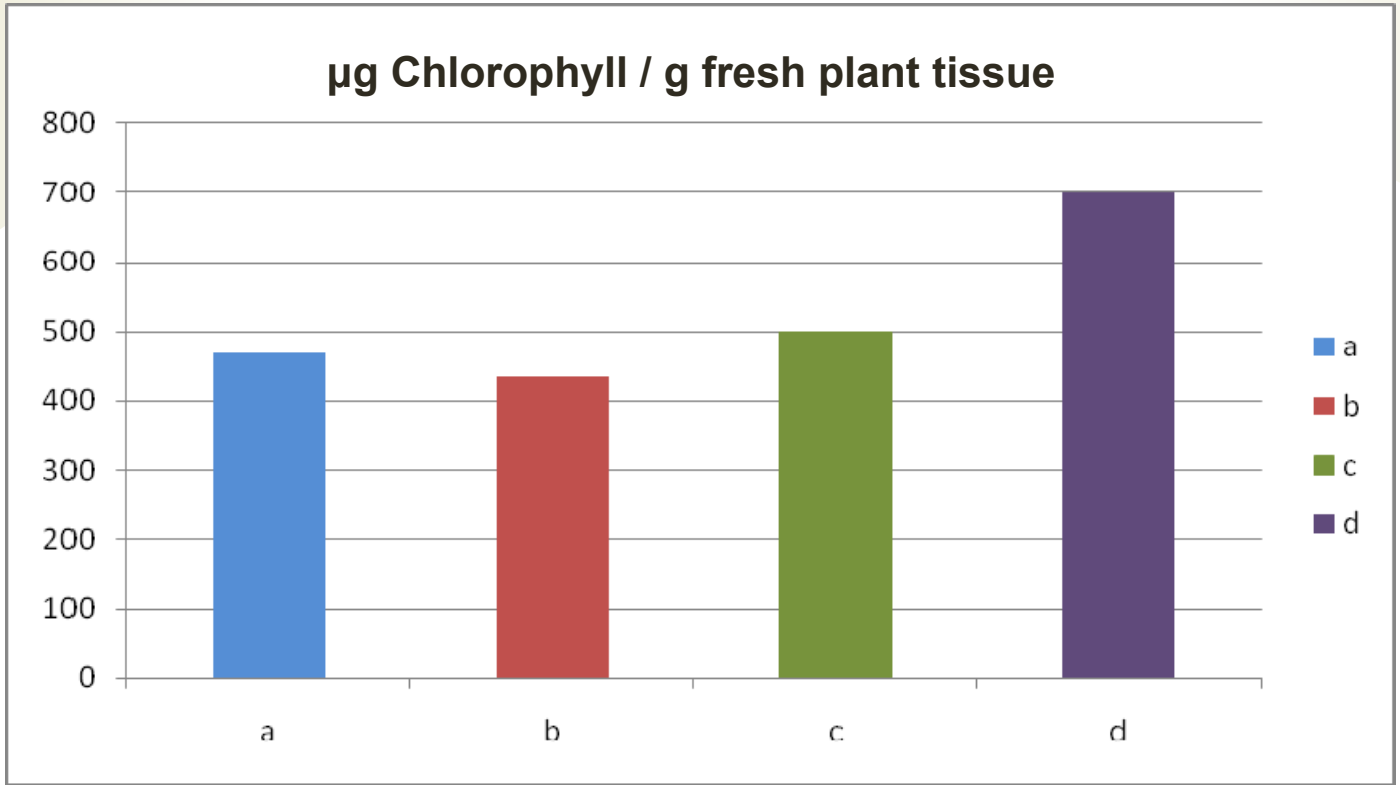
Evaluation parameters in the OMW soil conditioner as compared with those of the Greek regulations

PARAMETERS [1] mg kg^{-1} (dry basis)	LIMITS[2]	OMW soil conditioner
Cd	≤ 3	0.2
Cr	≤ 250	0.1
Cu	≤ 400	40
Hg	≤ 2.5	nd
Ni	≤ 100	28
Pb	≤ 300	0.05
Zn	≤ 1200	123
As	≤ 10	nd
PCBs[3]	≤ 0.4	nd
PAHs[4]	≤ 3	nd
Salmonella Spp.	0	0
Admixtures > 2 mm %	≤ 3	1.8
Moisture %	< 40	36

[1]Standards methods EN 13650:2001
[2]Governmental Ministerial Decision 56366/4351 2014
[3]Polychlorinated biphenyls
[4]Polycyclic Aromatic Hydrocarbons

µg Chlorophyll / g fresh plant tissue

Preliminary experiments on lettuce, Lactuca sativa (Asteraceae) seedlings growth under the influence of the produced OMW soil conditioner, based on the Chlorophyll mass / g fresh plant tissue



Four mixtures were used as development substrates:

a- 100 % v/v Perlite

b- 50 % v/v Perlite : 50 % v/v OMW produced soil conditioner

c- 66.66 % v/v Perlite : 33.33% v/v OMW produced soil conditioner

d- 100 % v/v OMW produced soil conditioner

Preliminary experiments *on VEGETABLES growth under the influence of the produced OMW soil conditioner

FIELD EXPERIMENTS ON VEGETABLES

During the planting seedlings on the line:

50 plants by adding 250 g “produced soil conditioner" in the planting pit
50 plants by adding 250 g other compost from OMWW in planting pit
50 plants by adding 500 g “produced soil conditioner"
50 plants by adding 500g other compost from OMWW in planting pit
50 plants without any soil conditioner (control)

- Showed no phytotoxicity as soil medium component in vegetable plantations and ornamental plants.
- Logged positive effect on plant growth
- Could replace the much more expensive peat substrates

***Experiments were performed in the farms of the Union of Agricultural Cooperatives of Rethymnon, Crete**