Management of Olive Mill Wastes in Greece

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Olive growing areas in Greece

- Crete
- Peloponnese
- Corfu
- Lamia
- Chalkidiki
- Lesvos
- Rhodos
- Sparti
- Pyrgos

58% of the production in semi- & mountainous areas
Distribution of olive trees in Greece

- Aegean Islands
- Macedonia
- Thessaly
- Hepiros
- Crete
- Western Greece
- Central Greece
- Peloponese
### Evolution of olive culture in Greece

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (ha x 10^4)</th>
<th>No trees (x 10^6)</th>
<th>Oil (ton x 10^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>50</td>
<td>80</td>
<td>180</td>
</tr>
<tr>
<td>1980</td>
<td>75</td>
<td>115</td>
<td>260</td>
</tr>
<tr>
<td>2000</td>
<td>90</td>
<td>150</td>
<td>420</td>
</tr>
</tbody>
</table>

*Source: National Hellenic Statistical Service*
Olive Mill Structure in Greece

**Typical characteristics:**

1) Family owned, small enterprises (more than 2,000).

2) They cannot afford sophisticated OMW treatment facilities.

5) Average processing capacities
   - Classical (press): 0.4-2.0 ton/h
   - Centrifugal: 2.0-8.0 ton/h

7) There is no political will to enforce existing Environmental Legislation.

8) Nearby houses and hotel owners are dissatisfied with prevailing odors and the current state of the rivers.
Olive mills and distribution in Greece

Geographical distribution of Greek olive oil mills.

- Peloponnesus: 36% (834)
- Crete: 23% (539)
- West Greece: 18% (411)
- Central Greece: 11% (261)
- North Greece & Aegean Islands: 12% (280)

TOTAL: 2325
Olive Oil Extraction Methods in Greece

Olive Oil Extraction Methods

87%
8%
5%
Geographical distribution of Greek olive pomace industries

- **TOTAL: 31**
  - Peloponnesus: (10)
  - Crete: (9)
  - West Greece: (4)
  - Central Greece: (4)
  - North Greece & Aegean Islands: (4)

Average processing capacities: 5-80 ton/year
OMW legislation problems

- Till 2011 no regulation specifically addressing OMW existed.
- The main principles for OMW management were based on the Law 1650/86 “For the Protection of the Environment” «olive mill owners are obliged to provide an environmental impact assessment study».
- The updated circular letter YM/5784/23-1-1992 (No 4419/23-10-1992) and the Law 3010/2002 refer to the problems encountered due to OMW disposal, the need for an efficient pretreatment and the care required in order to avoid disposal to various water resources.
- Regional environment offices are supplying working licenses to olive mills. For example, OMW management in the Prefecture of ‘Messinia’ is based on the modification of a 3-phase decanter system into a 2-phase, in the Prefecture of Lesvos olive mill wastewater was discharged until recently untreated onto aquatic ecosystems and in Prefecture of Crete the storage in evaporation ponds were obligatory.
- They are not convinced that they can enforce (or clearly suggest) the use of a particular technology.
March 8, 2011

- New law on REUSE of municipal & industrial wastewater (Joint K.Y.A. 45118/02-02-2011)
- OMW has not been explicitly included... So, came the Joint Ministerial Decision (KYA) 145116/2011

- It regulates the reuse of treated wastewater for several purposes, including irrigation in arable lands. The minimum requirement is the use of a biological treatment and disinfection units.
Current situation in Greece

OMW production in Greece:
- There are more than 2000 olive mills
- The majority of OM uses 3-phase systems

More than 2,750,000 tn OMW produced annually in Greece in a period of 4-5 months

Although OMW is a natural product, it can pollute water bodies and the environment because of its composition:
- High BOD (up to 50 g/l) and COD (up to 100 g/l)
- Low pH (≤5)
- High EC (7-11 dS/m) and ion content (mostly K)
- High phenolic content
- Smell and color
- Toxic properties for living organisms
OMW treatments in Greece

A large number of treatments have been tested in Greece:

- **Anaerobic biological treatment** mostly driven by bacteria, with biogas production.
- **Aerobic treatment** using specific aerobic microorganisms (has a very high cost of construction and operation).
- **Chemical treatment using limestone** (precipitation of suspended solids with increase of pH of OMW).
- **Use of membranes**. High cost, not affordable for the small oil mills.
- **Decentralized natural systems** (constructed wetlands) using different plant species are under test.
- **Production of composts for soil amendment**
- **Extraction of different compounds** (phenols, etc)

- The cost of application (construction and/or operation) is quite high in most cases, so it is not affordable by the small family-based olive mills.
- New technologies are developing...
OMW Treatment Plants in Greece

Aerobic biological trickling filter + Constructed wetland

Area: Amfilochia
Company: D. Vagenas
(U. Ioannina/U. Western Greece)

INPUTS:
OMW + pomace + leaves

Bioreactor: Continuous recirculation
with a residence time of 24 h
→ Sedimentation
→ Constructed wetlands

PRODUCT: compost (sludge + leaves + pomace)

Investment: 30,000 € equipment
+ land cost for CW
+ 5-10,000 € composting unit (OMW treated: 30 m³/day)
Evaporation – Hydrolysis – Oxidation: E.H.O.®

Area: Sparti (Laconia)

Company: ENVITEC A.E.

INPUT: Raw OMW

PRODUCTS:
1) Irrigation water (80-85% OMW)
2) Bio-fuel 4,000 kcal/kg
(in powder form 10 ton from 100 m³ OMW)

Investment cost: 100-150 € / m³ (i.e., for 1000 m³ OMW → 100-150,000 €)
OMW Treatment Plants in Greece

CIP-Eco-innovation: Filtration with sawdust & phytoremediation

Area: Alagni (Heraklion)
Company: MESOGIAKI SA)

Sequential filtration of OMW through a series of filters of
- Natural materials (peat, sawdust, no need for Ca(OH)2 addition)
- Chemicals (resins)
  - COD reduction by 75-80%.

Phytoremediation: “Light OMW” taken to poplars
- Extraction of polyphenols from ion exchange resins) (important source of income).
- Composting of sawdust & leaves
- Capacity: 1500 to 2.000 m3/year OMW
OMW management in Greece

Pilot anaerobic biological OMW treatment in Crete

Coagulation with Ca(OH)2

Production of compost in Crete

Storage + Irrigation
The present situation:
Storage in open evaporation ponds (lagoons), after a soil survey (paid by mill owners)
or
- Direct disposal into the rivers or the sea causing serious environmental problems

Advantages:
Low or without cost

Disadvantages:
- Pollution of surface or ground waters
- Centers for development of different insects
- The odors produced cause serious problems in villages or tourists

To reduce bad odors CaO is added.
The solid residues, after the evaporation of liquids, with the proper treatment can be used as soil amendment.
OMW application on olive orchards

Research has shown that soils can be used as a natural system for OMW treatment since organic compounds are fast decomposed and soils have high buffering capacity. Our 5-year research shown that OMW application, under certain conditions and doses, at olive orchards:

- Increase soil fertility (mostly K)
- The organic part of OMW is fast decomposed
- There is no pollution of surface or ground water
- The required area of olive orchard is relatively small and can be easily found around each olive mill (4-5 ha)
- The cost of OMW application is low (0.007 €)

OMW can be considered as a useful, low cost soil amendment and fertilizer.

Update of legislation (guidelines) is required.

Usage of 3-phase pomace

• Extraction by chemical means of crude-olive-kernel-oil.
• Treatment of olive-pulp for production of crude-olive-kernel-oil
• The segregation of exhausted olive-oil-pulp for production of forage.
• Composting (with other agricultural residues)
• The exhausted olive cake, which is a solid combustible (biomass) with calorific power of about 4500 kcal/kgr, is used for heating (by burning)

Burning of olive pomace and dried pomace wood has to follow the regulations applied for all solid materials (ministerial decisions 69269/5387/1990 & 58751/2370/1993) regarding the gas emissions (SO2, NOx, particles)

EU Directive 2004/35/EK for environmental protection 2006/12/EK for solid wastes
Usage of 3-phase pomace

Compost production
Usage of 3 or 2-phase pomace

- Pomace wood
- Pomace pellets
- Heating (by burning)
- Gasification plants for electricity?
Thank you for your attention!