Harokopio University

eSymbiosis

Estimating the bioremediation of green table olive processing wastewater using a selected strain of *Aspergillus niger*

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Aims

This study aims:

To explore the aerobic biological treatment of Table Olive Processing Wastewater (TOPW - debittering of Spanish type green table olives), through the bioremediation potential of a selected strain of ***Aspergillus niger***

To investigate the effect of replacing NaOH with KOH as a debittering agent, on the wastewater degradability.

Ultimately, to investigate the influence of wastewater **concentration** on the fungus biodegradation ability.

TABLE OLIVES PRODUCTION

Table olive production is becoming increasingly important for the **agro-industrial sector** and the **economy of rural** areas in countries as diverse as Italy, Spain, Greece, Turkey and Tunisia.

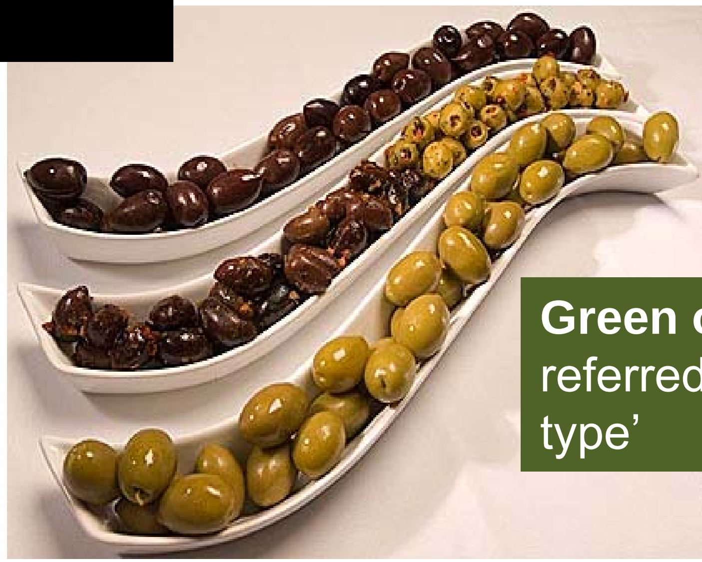
World production of table olives:
1990-91: 950,000 tons
2005-06: 1,800,000 tons

Greek production rose from 70,000 to 123,000 Mg/y in the same period.

Mediterranean countries are the main producers

The main types of table olives are:

Black olives



Green olives, often referred to as 'Spanish type'

Preparation, production and wastewater

Preparation: | **Production:** | **Wastewater:**

Green olives

- Crop selection and cleaning
- Debittering using NaOH solution
- Washing
- Fermentation
- Canning

Production has a strong seasonal character, mainly occuring from September to November before olive ripenig on the tree.

The largest amount is produced through the debittering and the washing stages.

Black olives

- Crop selection and cleaning
- Fermentation
- Canning

Production spread throughout the year

Table Olive Processing Wastewater (TOPW)

Wastewater production:

- Black olives: 0.9-1.9 m^3/Mg
- Green olives: 3.9-7.5 m^3/Mg

Characteristics of TOPW:

- pH = 3.6-13.2
- dissolved solids = 0.2-80.0 g/l
- BOD = 0.1-6.6 g/l
- COD = 0.3-18.2 g/l
- sodium chloride = 0-80.0 g/l
- suspended solids = 0.03-0.4 g/l

+ polyphenols, which hinder its biological treatment and prevent its direct application to soil due to their biotoxic properties.

Treatment of wastewater:

- **Biological** (aerobic or anaerobic processes)
- **Advanced oxidation** processes (ex.: ozonation, UV, Fenton)
- **Combination** of processes

Wastewater used:

Fresh debittering wastewater & washing effluents

Derived from a single production plant (Agricultural Cooperation of Rovies, Evia, Greece).

Sampled from 2 different production lines (in duplicate basins):

The typical debittering process, using NaOH

An alternative process replacing NaOH with KOH

•5 duplicated TOPW dilutions examined for each treatment and basin (TOPW concentration: 100%, 85%, 70%, 55% and 40%).

Experiment[1]	COD_0 (g/L)[2]	pH	EC (mS/cm)
$S1_{100}$	21.6	11.95	10.67
$S1_{85}$	17.6	12.15	9.92
$S1_{70}$	15.6	11.92	8.77
$S1_{55}$	11.2	11.50	7.42
$S1_{40}$	6.6	11.40	5.46
$S2_{100}$	14.5	12.09	9.09
$S2_{85}$	14.4	11.91	7.82
$S2_{70}$	7.9	11.73	6.53
$S2_{55}$	9.1	11.85	5.53
$S2_{40}$	4.9	11.71	4.03
$P1_{100}$	18.4	11.32	8.75
$P1_{85}$	12.0	11.24	7.69
$P1_{70}$	10.4	11.18	6.43
$P1_{55}$	7.9	11.21	5.23
$P1_{40}$	2.9	11.16	4.10
$P2_{100}$	14.5	11.55	9.01
$P2_{85}$	10.2	11.53	7.72
$P2_{70}$	9.5	11.50	6.52
$P2_{55}$	7.1	11.26	5.34
$P2_{40}$	5.8	11.28	3.88

S and P denote debittering with NaOH and KOH, respectively;

the subscript denotes TOPW concentration.

COD_0 at 0h

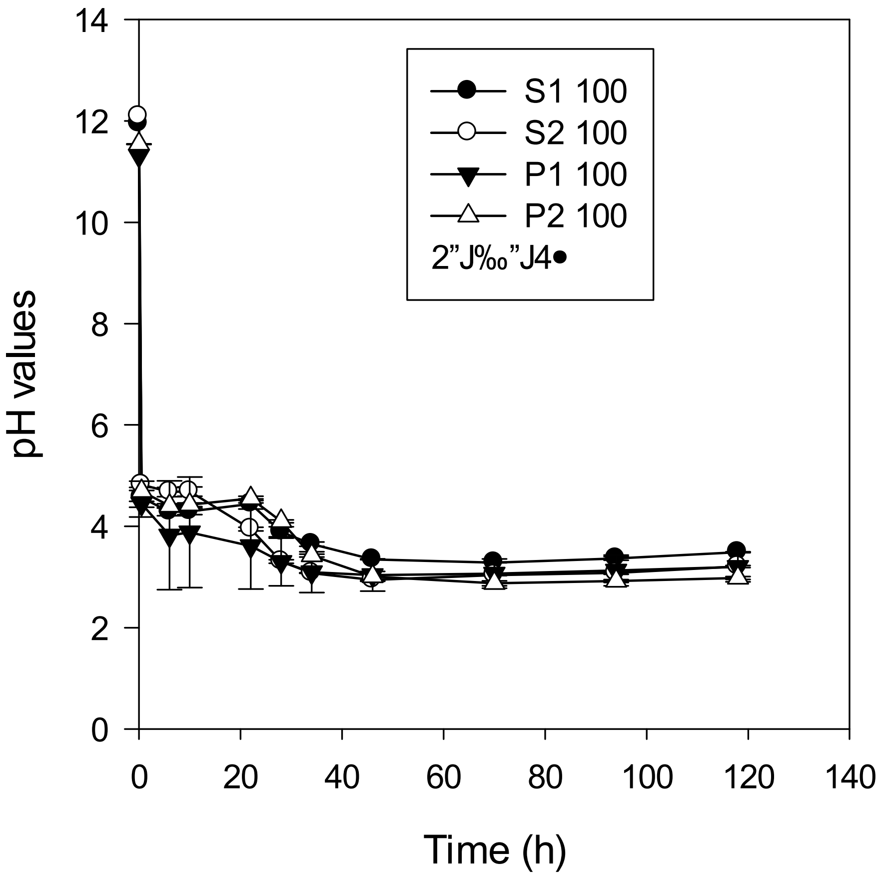
- The wastewaters were inoculated with the acid producing filamentous fungi *Aspergillus niger* (strain B, Harokopio University Collection).
- pH adjusted to 4.4-4.9 with conc. H_2SO_4 to increase selectivity for *A. niger*
- Laboratory scale treatment, non-sterile system, using 2L Erlnemeyer flasks containing 400ml of acidified TOPW
- The inoculated flasks were continuously shaken on a rotary incubator operating at 180 rpm, at 25^{o}C, for 118 hours.
- Sampling at regular intervals (0, 6, 10, 22, 28, 34, 46, 70, 94 and 118h)

Analytical methods

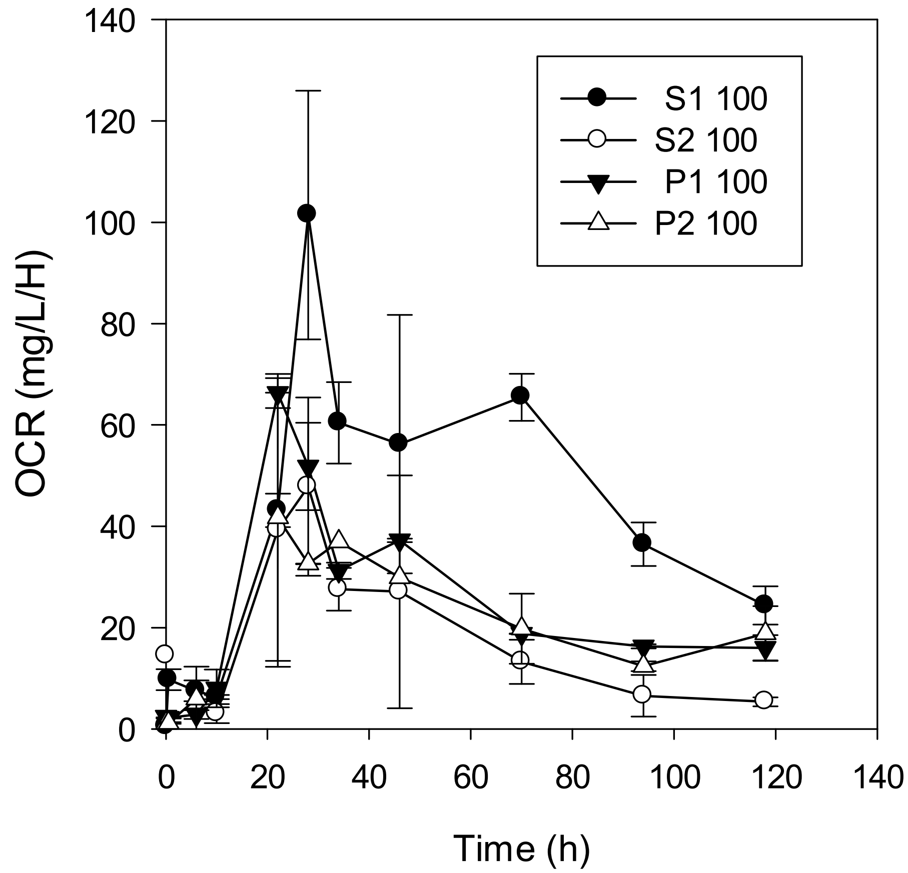
- Electrical conductivity EC
- pH value
- COD
- Total solids (TS) & total suspended solids (TSS)
- Volatile solids (VS) & volatile suspended solids (VSS)
- Respiration rate, determined as oxygen consumption rate (OCR – mg O_2/L/h)
- Total phenols (TP) (Folin-Ciocalteau)

Results

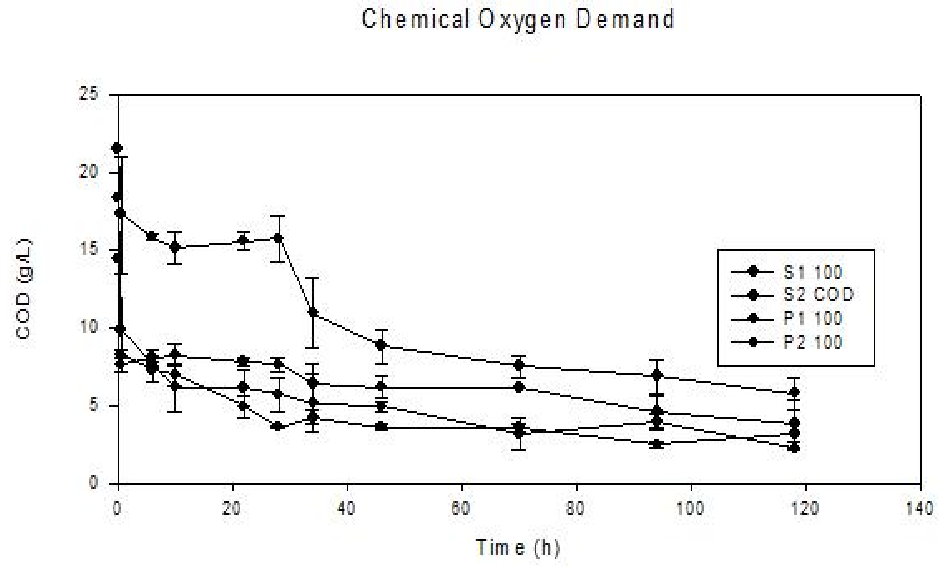
pH values

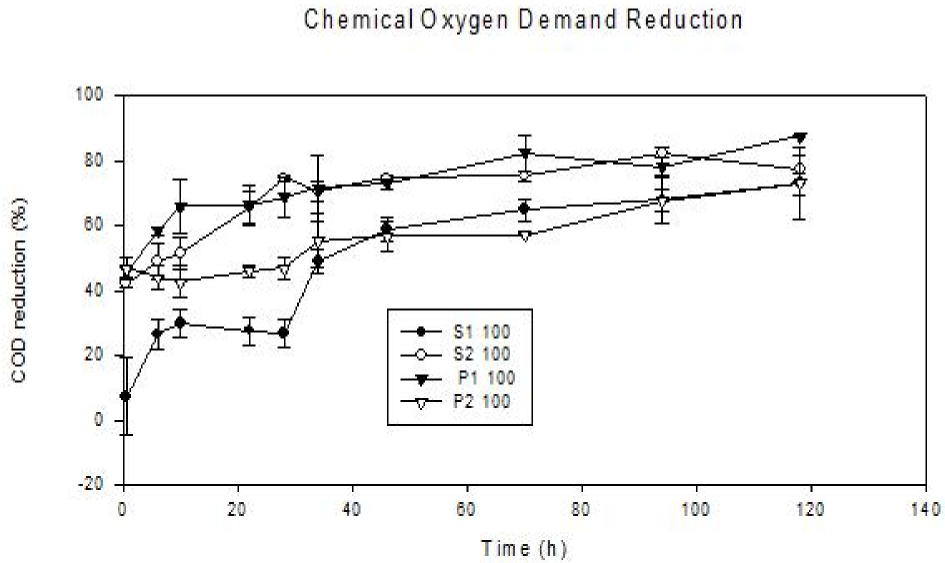


Oxygen Consumption Rate



Results





- NaOH debittering: COD varied among the two replicates ($S1_{100}$, 21.6g/L; $S2_{100}$, 14,5g/L).
- COD reduction of all five dilutions: 60 - 87%
- Initial COD for KOH treatment: 3.0 - 18.4 g/l, COD removal efficiency: 50 - 87%.
- The COD reduction did not differ significantly for the replicate treatments. COD reduction was satisfactory for both debittering processes.

Conclusions

- Although a large part of the organic load was removed from the TOPW through its biological treatment with *A. niger* (removal efficiency 50-87%), a substantial amount remained requiring further treatment, probably using advanced oxidation processes.
- Substituting NaOH with KOH in the debittering process was shown to be a promising and feasible process, as the treated wastewater may be beneficially added to the soil. Investigation on the organoleptic and conservation properties of the so produced olives also indicates the feasibility of this approach.
- The biodegradation of polyphenolics and their potential contribution to the inhibition of the wastewater biodegradation requires further investigation.

Thank you for your attention!