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Adding value to olive oil production through waste and wastewater treatment and valorisation: the case of Greece

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eSymbiosis

Objectives

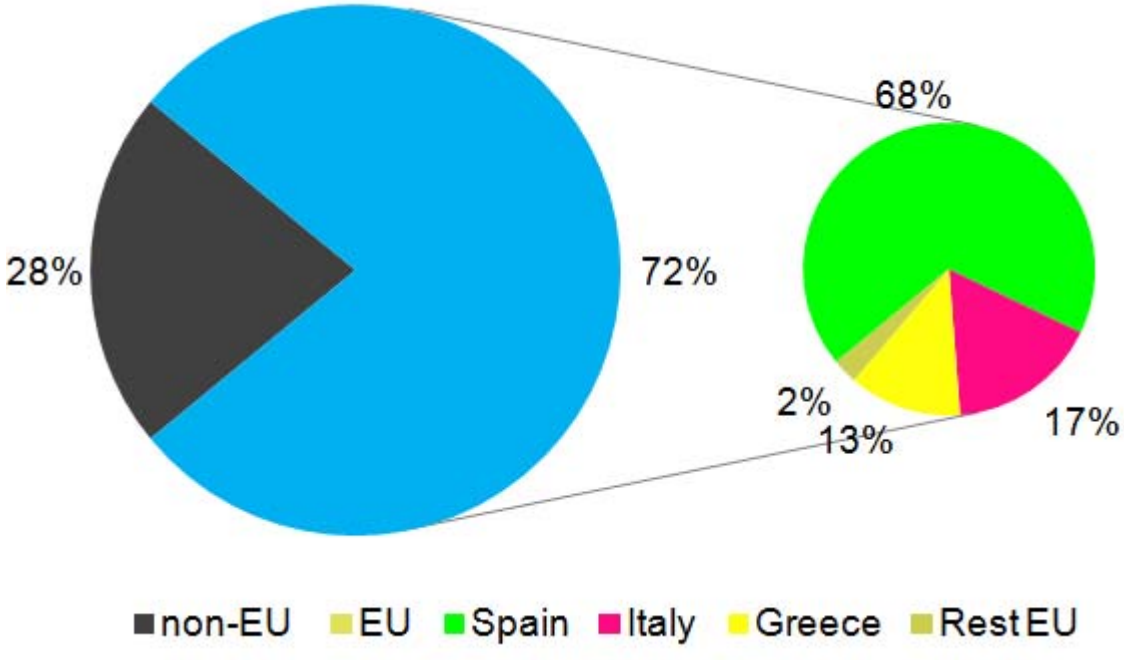
Main objective

Investigation of the potential of adding value to the Greek olive oil production process through wastewater and solid waste treatment and/or valorisation

- Recording the existing treatment practices applied in Greece for waste and wastewater from olive oil processing
- Reviewing waste and wastewater treatment methods and valorisation options proposed through various publications and presentations worldwide

Numbers….

In 2011/2012, **global olive oil production** reached **3.3 millions of tons**



72% comes from **EU:**

Spain: 68%

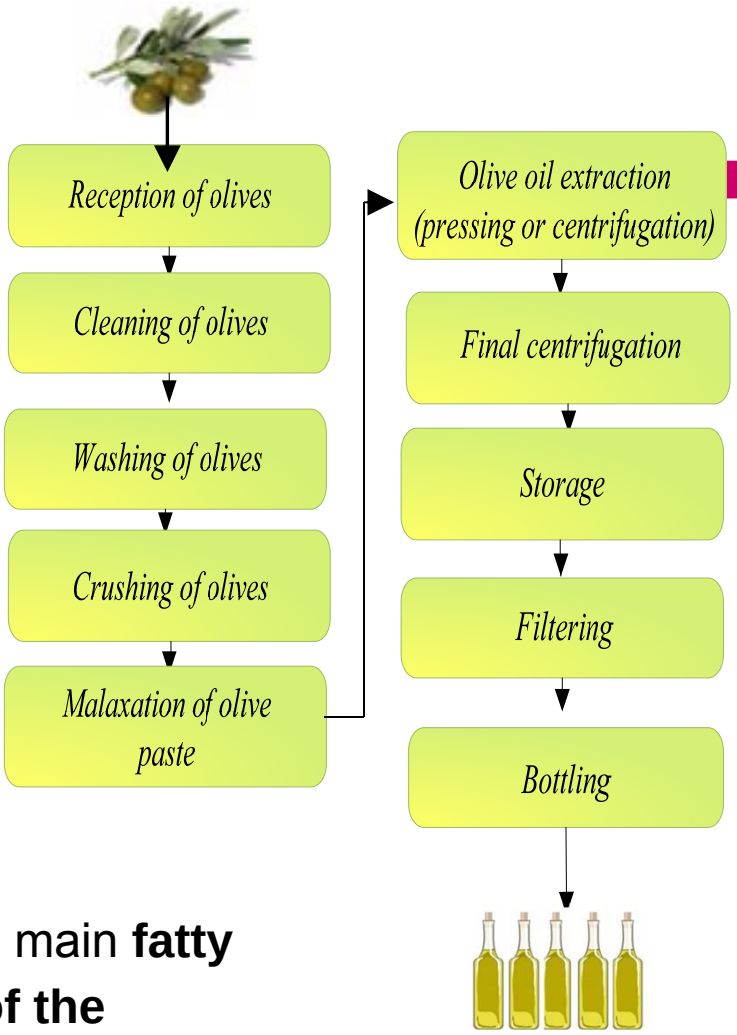
Italy: 17%

Greece: 13%

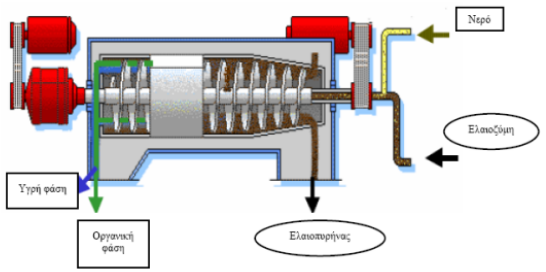
Approximately, **75%** of the Greek olive oil is produced in **Crete** and **Peloponnese**

Greece has an annual production ranging from **300 up to 400 thousands** of tons of oil depending on the olive crop year

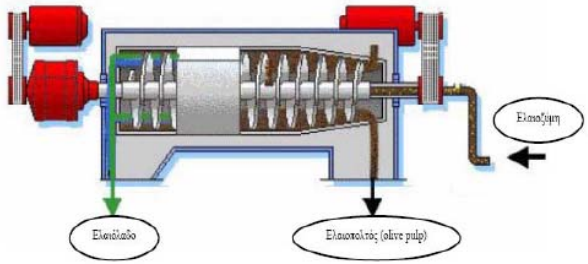
General: the olive oil production process



Pressing



3-phase



2-phase

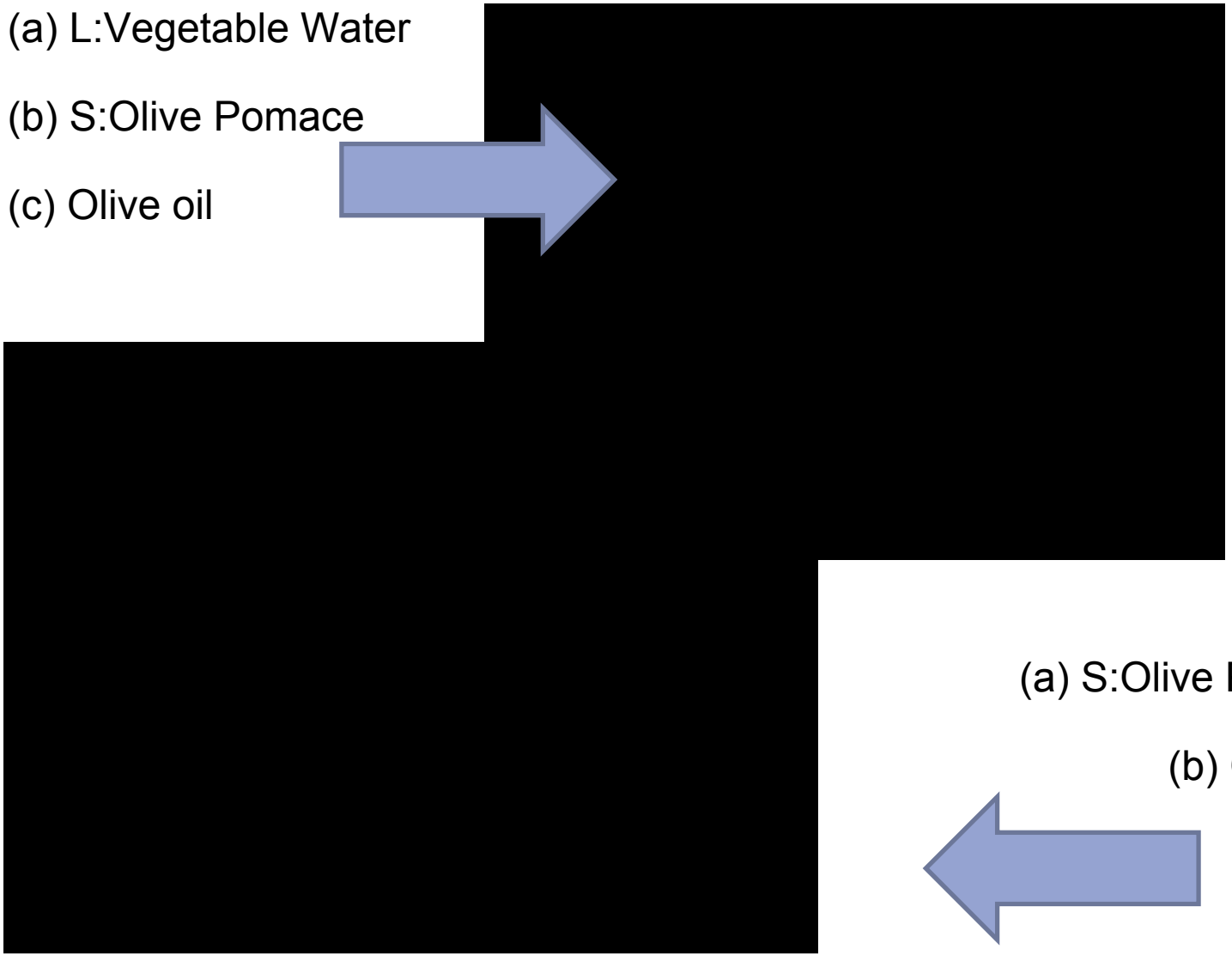
Olive oil is the main **fatty component of the Mediterranean diet**.

General: the olive oil production process

(a) L:Vegetable Water

(b) S:Olive Pomace

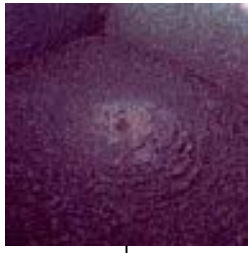
(c) Olive oil



(a) S:Olive Pomace

(b) Olive oil

General: the olive-pomace oil production process



Olive-pomace oil plants process the pomace produced from the two or three phase olive oil mills for the production of olive-pomace oil

Reception and storage of fresh pomace

Drying of pomace

Extraction of dry pomace

Distillation

Separation of hexane-water

Olive pomace oil

Pomace wood

Orujillo
Sansa esausta
Pirinoxilo

Methodology

1st
- Gathering secondary data on Greek companies active in the filed of olive/pomace-olive oil production

2nd
- Gathering primary data related to waste and wastewater applied treatment methods in Greece

3rd
- Recording and categorizing primary data collected during step 2

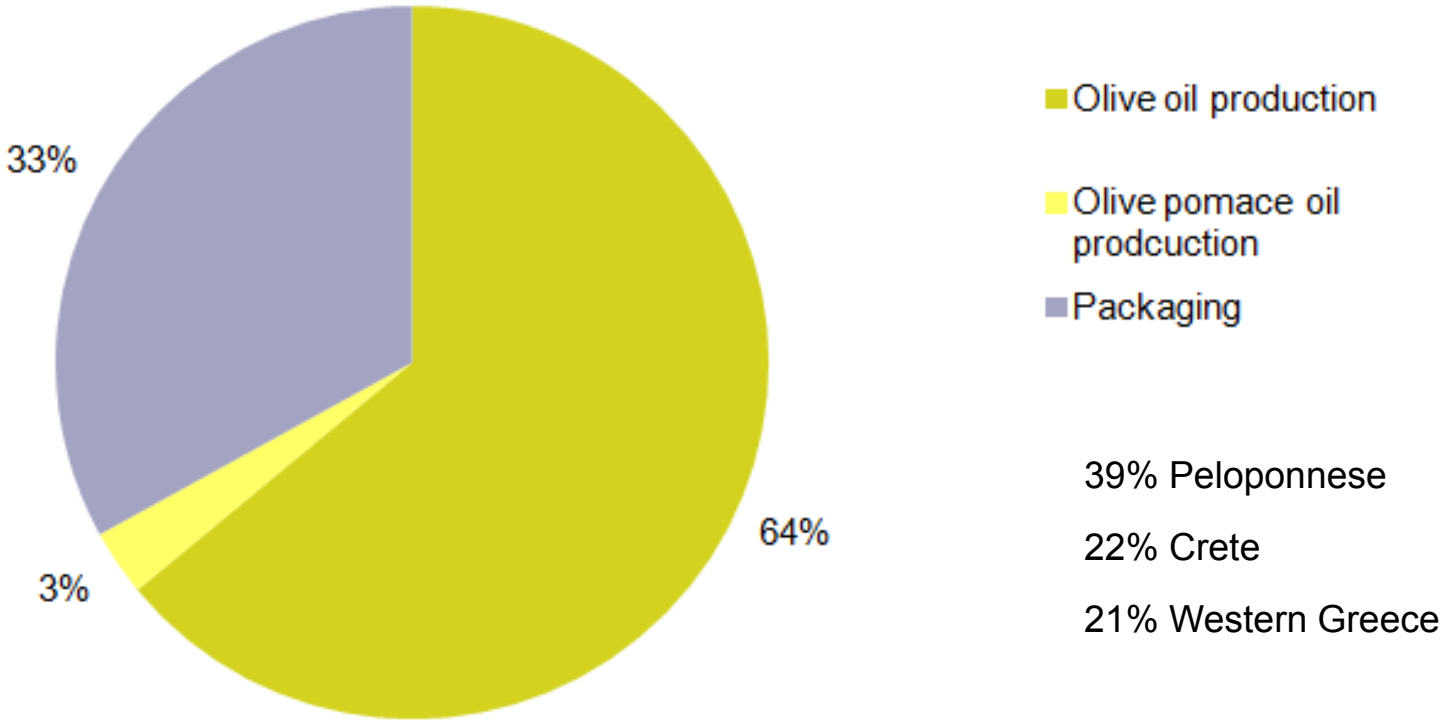
4th
- Evaluation of waste and wastewater current treatment status from the Greek olive oil processing industries

Results & Discussion – Step 1

1st

- *Gathering secondary data on Greek companies active in the filed of olive/pomace-olive oil production*

How many recorded? *254*



39% Peloponnese

22% Crete

21% Western Greece

Results & Discussion – Steps 2 & 3

2nd

- Gathering primary data related to waste and wastewater applied treatment methods in Greece

3rd

- Recording and categorizing secondary collected during step 2

How many recorded? *22*

- ✓ 16 are involved in oil production (olive oil mills), of which 9 have extended their activity to packaging of olive oil
- ✓ 2 are exclusively active in the packaging of olive oil and
- ✓ 4 in the production of olive-pomace oil and pomace wood, of which 3 are also engaged in packaging of olive-pomace oil while 1 of them also produces soaps

Classification of activities under Ministerial Decision (MD) 1958/12

- ✓ 50 % Category A2
- ✓ 50% Category B

Results & Discussion – Step 3

3rd

- Recording and categorizing secondary collected during step 2

Table 1: Recorded and categorised data for solid waste and wastewater treatment in 22 olive and olive-pomace oil industries in Greece

no	Activity	Capacity	Process of oil extraction	Industrial wastewater type and quantity	Industrial wastewater treatment	Industrial wastewater disposal	Industrial solid waste type and treatment	Sludge treatment and disposal
1	OO-FF[3]	Olive oil mill: 9 *t olives/ d*	2-phase	0.25 m^3/ *t olive* (2 m^3/d)	Neutralization of acidity Flocculation Precipitation	Transportation to the municipal wastewater treatment plant	Pomace: to olive-pomace oil production facilities Olive leaves: for animal feed	n.a.
2	OO-FF	n.a.	2-phase	n.a.[4]	Neutralization of acidity Flocculation Precipitation	Surface water receptor	Pomace: to olive-pomace oil production facilities Olive leaves: animal feed or soil improver or fuel Ash: disposal with MSW or for fertilizing	Sludge (precipitation tank): T[5] - collection, dehydration, D [5]- soil improver
3	OO-FF	n.a.	2-phase	n.a.	Oil collection Neutralization of acidity Precipitation Evaporation in ponds	- [7]	Pomace: to olive-pomace oil production facilities Olive leaves: animal feed or soil improver or fuel Ash: disposal with MSW or for fertilizing Damaged olives: animal feed or soil improver or for biogas production	Sludge (evaporation ponds): T - collection, dehydration, D - soil improver
4	OO-FF	n.a.	2-phase	n.a.	Oil collection Neutralization of acidity Precipitation Evaporation in ponds	-	Pomace: to olive-pomace oil production facilities Olive leaves: animal feed or soil improver or fuel Ash: disposal with MSW or for fertilizing Damaged olives: for animal feed or soil improver or for biogas production	Sludge (evaporation ponds): T - collection, dehydration, D - soil improver
5	OO-FF	Olive oil mill: 15 *t olives/ d* Olive oil production: 3 *t olive oil /d*	2-phase	n.a.	Screening Neutralization of acidity Precipitation Evaporation in ponds	-	Pomace: to olive-pomace oil production facilities Olive leaves: soil improver	Sludge (evaporation ponds): T - collection, mixing with olive leaves, D - soil improver
6	OO-FF	Olive oil mill: 20 *t olives/ d* Olive oil production: 5 t /d	2-phase	n.a.	Oil collection Neutralization of acidity Precipitation Evaporation in ponds	-	Pomace: to olive-pomace oil production facilities Olive leaves: animal feed or soil improver or fuel	Sludge (evaporation ponds): T - collection, dehydration, D - soil improver
7	OO-FF & other oils	Vegetable oils: 192 *t of processed oil /d*	n.a.	25 - 30 m^3/d	Pre-treatment Physicochemical treatment Biological treatment	Surface water receptor	Gums, waxes and solid waste from the refining process: added to flour or sold to third parties as a by-product for use Sediment material (mourga): sold to third parties for use (soap)	Sludges: T&D: by appropriate waste treatment companies
8	OO-FF/ OO-FA [6]	*50 t olives/ d*	2-phase	1.2 *t/t olives*; 56 *t/d*	Neutralization of acidity Flocculation Precipitation Evaporation in ponds	-	Pomace: to olive-pomace oil production facilities Olive leaves: soil improver	Sludge (evaporation ponds): T - collection, dehydration, D - soil improver

Results & Discussion – Step 4

4th

- Evaluation

General observations

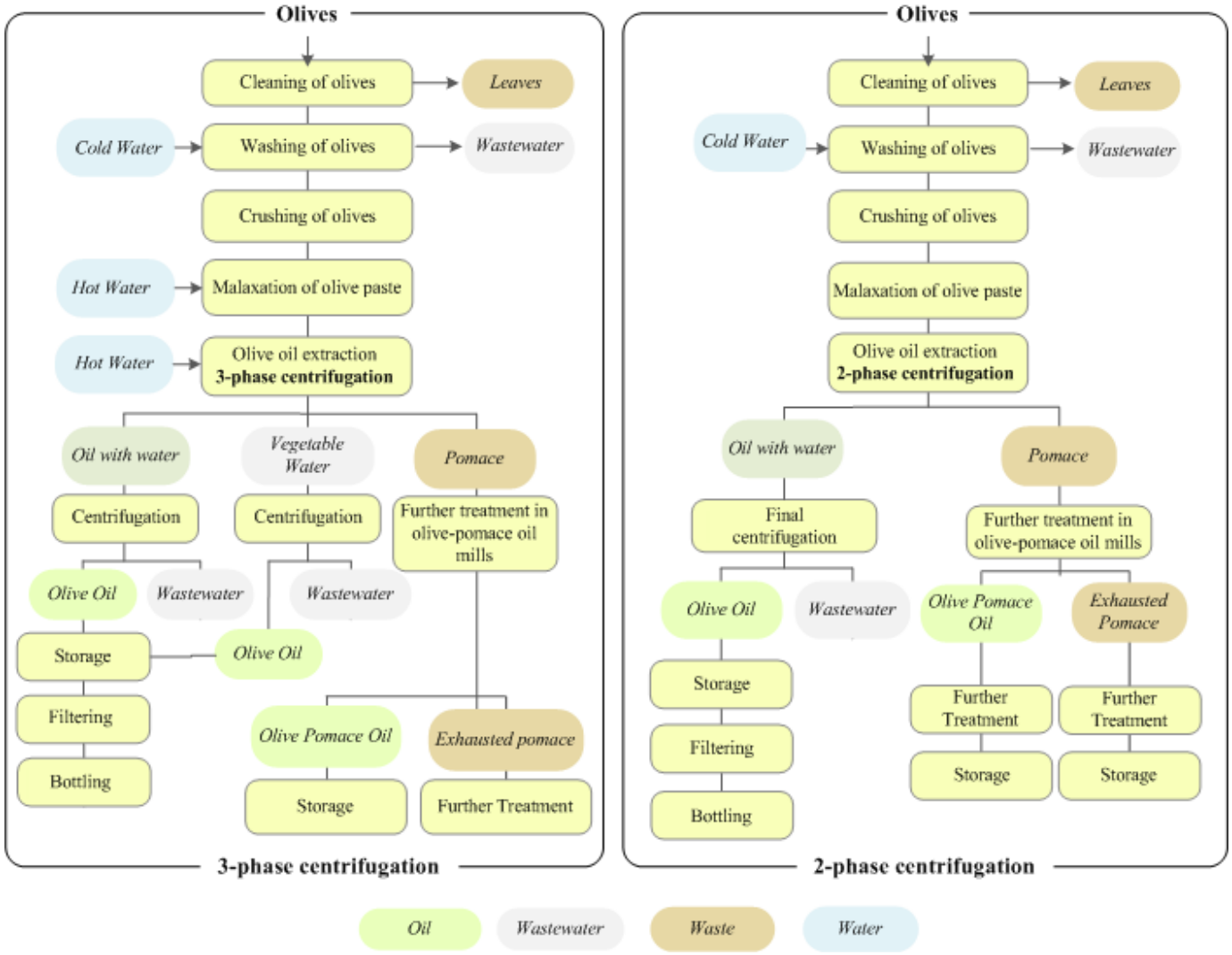
- ✓ Main products of the activities under investigation are: olive oil, refined oils, olive-pomace oil and pomace wood
- ✓ Other intermediate products or by-products that are financially exploited directly or indirectly include: (a) pomace which comprises the raw material for olive-pomace oil production, (b) sediment material from oil storage tanks (in Greek: mourga) which is sold to soap manufacturing industries and (c) olive leaves which are forwarded as animal feed
- ✓ Regarding the production processes of the examined industries, no big differences during the production of the same product were observed
- ✓ The majority of the studied olive oil mills (70%) were three-phase olive oil mills
- ✓ The method of extracting the oil determines both the capacity and the qualitative and quantitative characteristics of the resulting oil, wastewater and solid waste.

Results & Discussion – Step 4

4th

- Evaluation

Wastewater generation and treatment



Results & Discussion – Step 4

4th

- Evaluation

Wastewater generation and treatment

- ✓ Average ratio of produced wastewater (kg) per olives processed (kg) for 3-phase is much higher than that for 2-phase, 1.23 and 0.22 respectively. Vegetable water derived from 3-phase decanters is responsible for the high polluting load

- ✓ From the evaluation of data it was obvious that the prevailing waste treatment method that it is currently applied includes oil collection, neutralization of acidity, sedimentation and disposal to open evaporation ponds (lagoons)

Results & Discussion – Step 4

4th

- Evaluation

Wastewater generation and treatment

- ✓ Evaporation ponds are widely used worldwide despite the fact that in some cases only waste volume is reduced and serious problems might occur due to leakage of wastewater to soil and/or groundwater
- ✓ Despite that, the specific treatment method is a low cost method and thus widely applied
- ✓ According to the JMD 15/4187/266/11.04.2012 on *the Standard Environmental Commitments (SEC) of Industrial Activities* this is the proposed method for the treatment of wastewater from olive oil production in Greece

Results & Discussion – Step 4

4th

- Evaluation

Solid waste generation and treatment

- ✓ Pomace, olive leaves, inappropriate (damaged) olives, ash from the operation of burners, dust due to burners operation or due to drying of pomace and sludge derived from the evaporation, the precipitation and / or septic tanks
- ✓ Pomace handling is 100% undertaken by the olive-pomace facilities, where olive-pomace oil and pomace wood are produced
- ✓ Most Greek industrial units use olive leaves as animal feed or as fertilizer or as fuel
- ✓ Inappropriate olives are available as animal feed or soil improver or for biogas production
- ✓ The ash from pomace wood burners is disposed with municipal waste or to fertilization

Results & Discussion – Step 4

4th

- Evaluation

Solid waste generation and treatment

- ✓ Despite the fact that according to *Z8 condition* of JMD 15/4187/266/11.04.2012 sludge from the evaporation ponds should be disposed as soil improver after mixing and dehydration or with alternative treatment methods, during study it was not possible to record the exact circumstances that this is conducted in Greece. Nevertheless, sludge from evaporation ponds should not be applied directly to soil since this may entail risks due to toxic effects
- ✓ Solid residues from oil tanks available for making soap
- ✓ Dust from the dryers of pomace and from steam boilers initially undergoes extraction and then burned along with pomace wood in dryer's burner or steam boiler burner

LL on valorization opportunities in olive oil sector

Wastewater

- Bioenergy and Co-composting
- Production of biopolymers, enzymes and phenolic compounds
- Production of polysaccharides
- Pectins extraction
- Antioxidants production
- Dyeing textile materials

Pomace

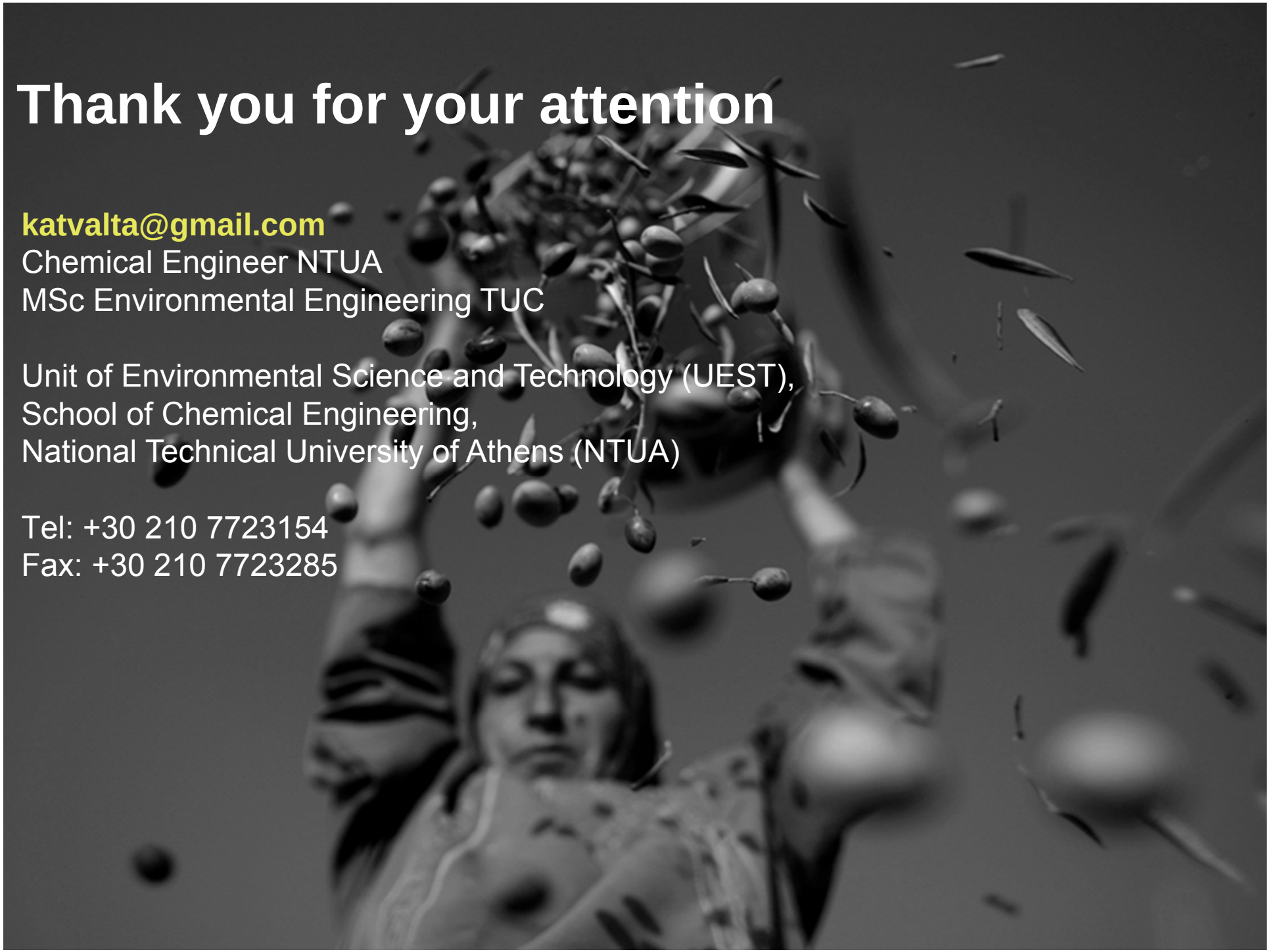
- For olive pomace oil production
- Sorbents
- Cultivation of mushrooms of the genus Pleurotus

General Conclusions

- From the evaluation of data it was obvious that the prevailing wastewater treatment method that it is currently applied in Greece includes oil collection, neutralization of acidity, sedimentation and disposal to open evaporation ponds
- This is a basic - level technique and thus alternative more advanced treatment options shall be applied resulting to better environmental protection along with other benefits e.g. bioenergy
- Valorisation of pomace is an excellent example of by-product exploitation, since waste produced from one industrial unit constitutes raw-material for another
- Moreover, sludge produced from evaporation ponds can used as soil improver but attention should be paid to the application conditions

General Conclusions

- Alternative valorisation options such as production of antioxidants, biopolymers, enzymes and dyeing textile materials, which have recently received a great deal of attention in various publications, needs to be further developed so as to increase feasibility of the processes towards industrial use; thus adding more value to olive oil production process



Thank you for your attention

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