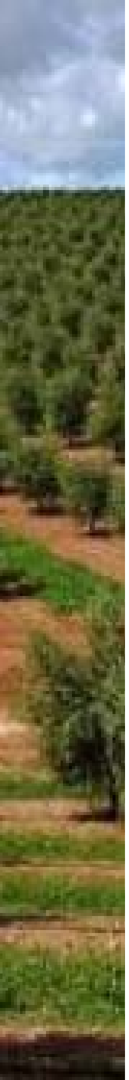
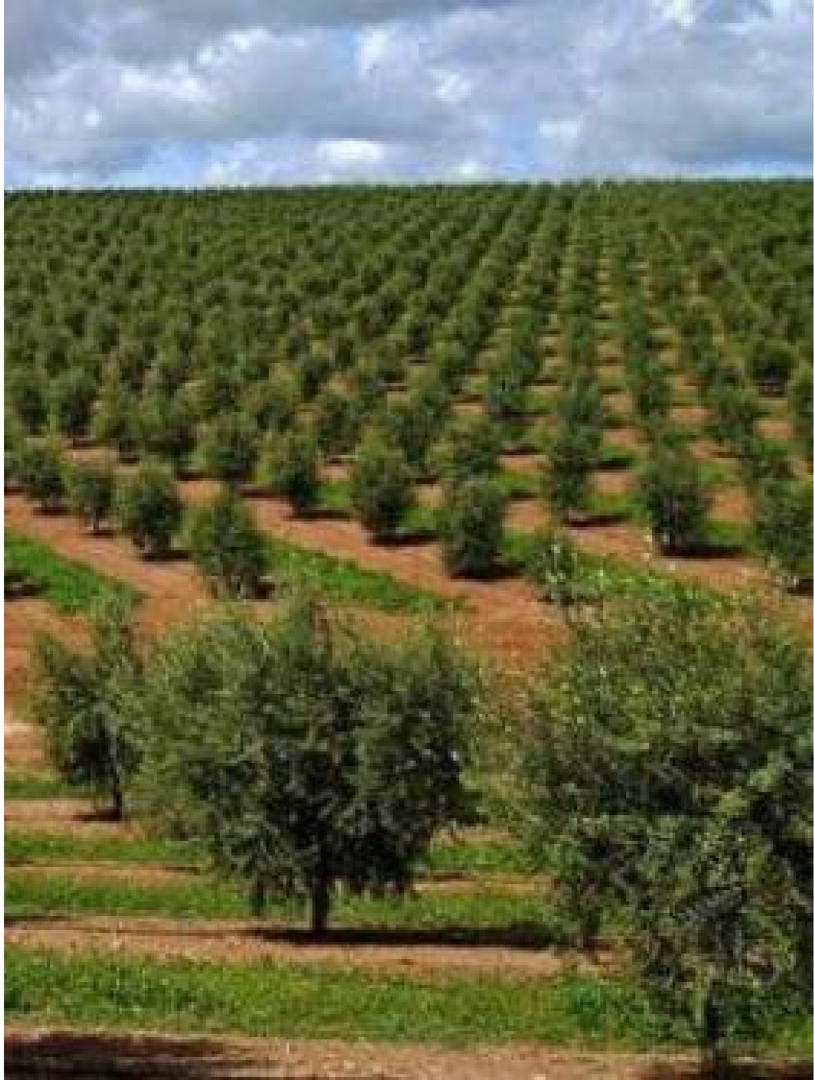


Anaerobic co-digestion of olive oil pomace as a strategy for bioenergy production in the MED region

THESSALONIKI 2021 Conference



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01

Olive oil production

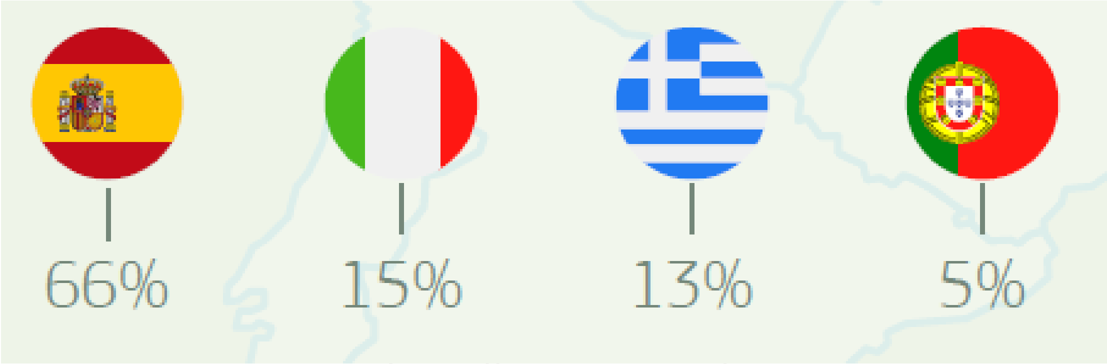
in numbers

About 3 million tonnes

of olive oil produced yearly

Of which c.a **2 million tonnes** in the EU

The main Member States involved are in the MED region:



https://ec.europa.eu/

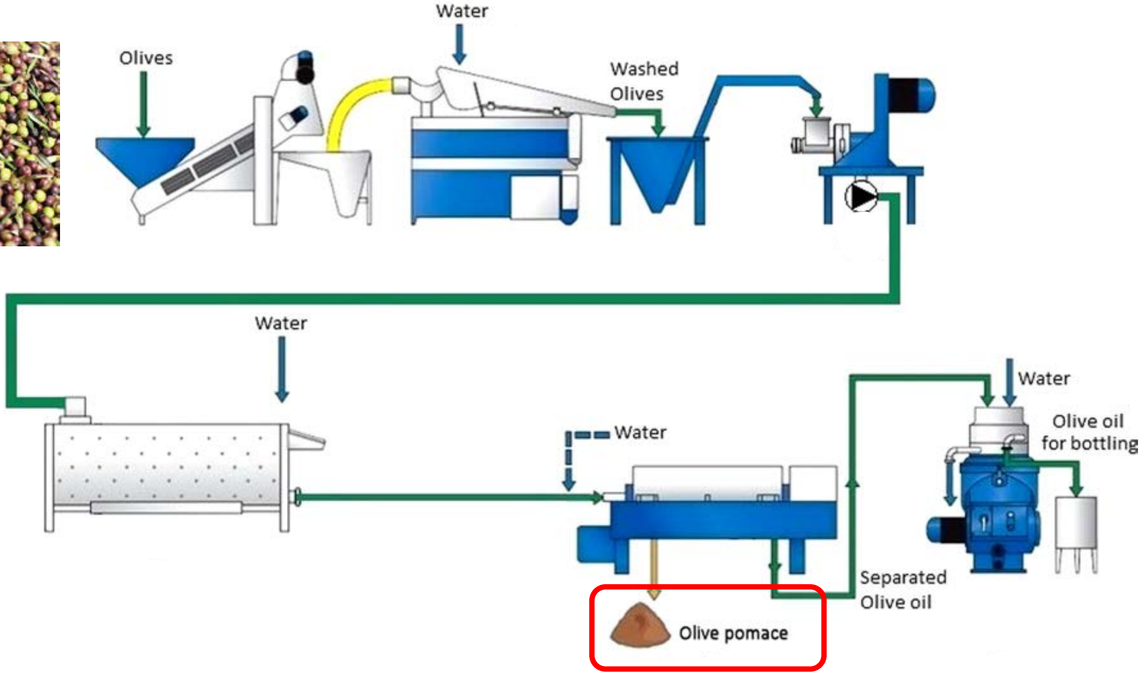
02

Problem

environmental pressure

Olive oil extraction

two-phase process



PROBLEM

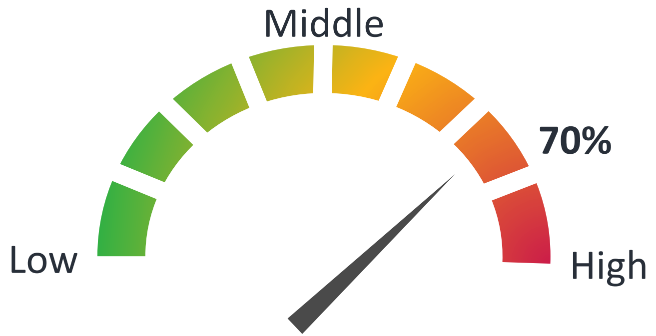
The production of 1 tonne of olive oil leads to 4 tonne of olive pomace (OP)

e.g around

5 000 000 tonnes

produced annually in Spain

OP high organic matter content, including phenolic compounds that are recalcitrant and **inhibitory/phytotoxic**



OP from two-phase system has **high water content**

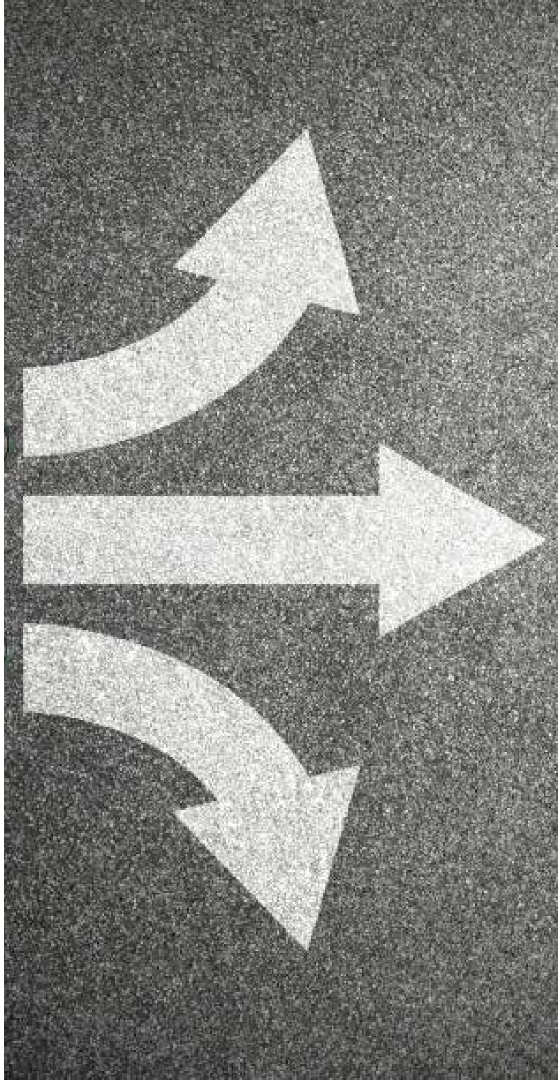
(vs 30-45% for three-phase OP)

As OP from two-phase system **needs to be dried before recovering the residual oil this valorisation has become less attractive**

Need to exploit alternative valorisation routes

- recovery of phenolic compounds
- composting
- anaerobic digestion

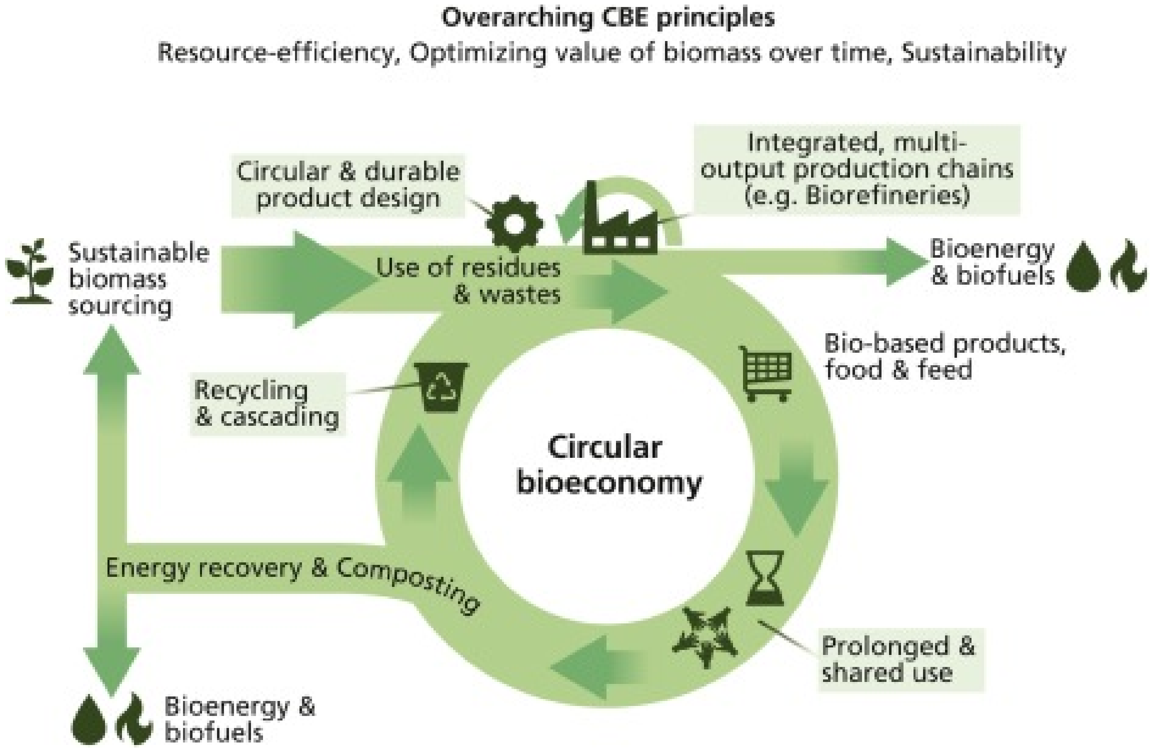
...



03

Economic context

Circular bioeconomy



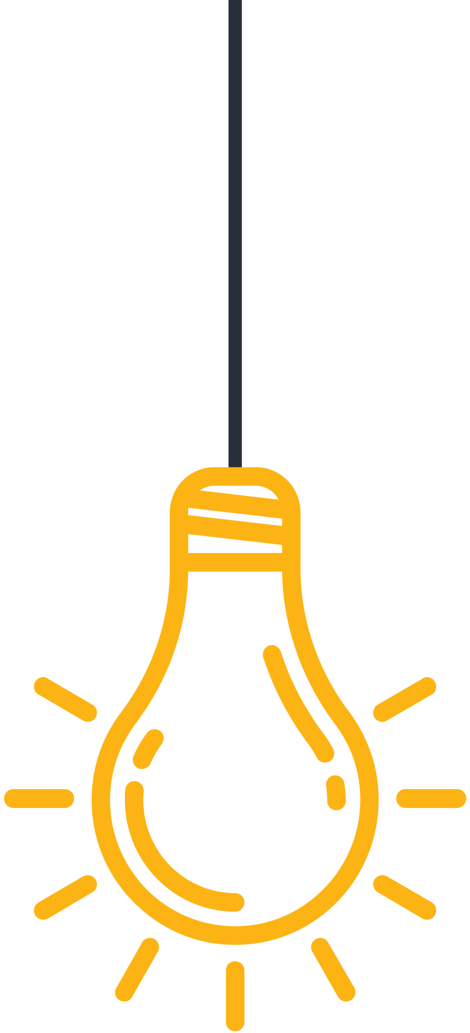
Stegmann et al.(2020) The circular bioeconomy: Its elements and role in European bioeconomy clusters doi.org/10.1016/j.rcrx.2019.100029

New economic paradigm pushing the pursuit for sustainable biowaste valorization routes

Cascading

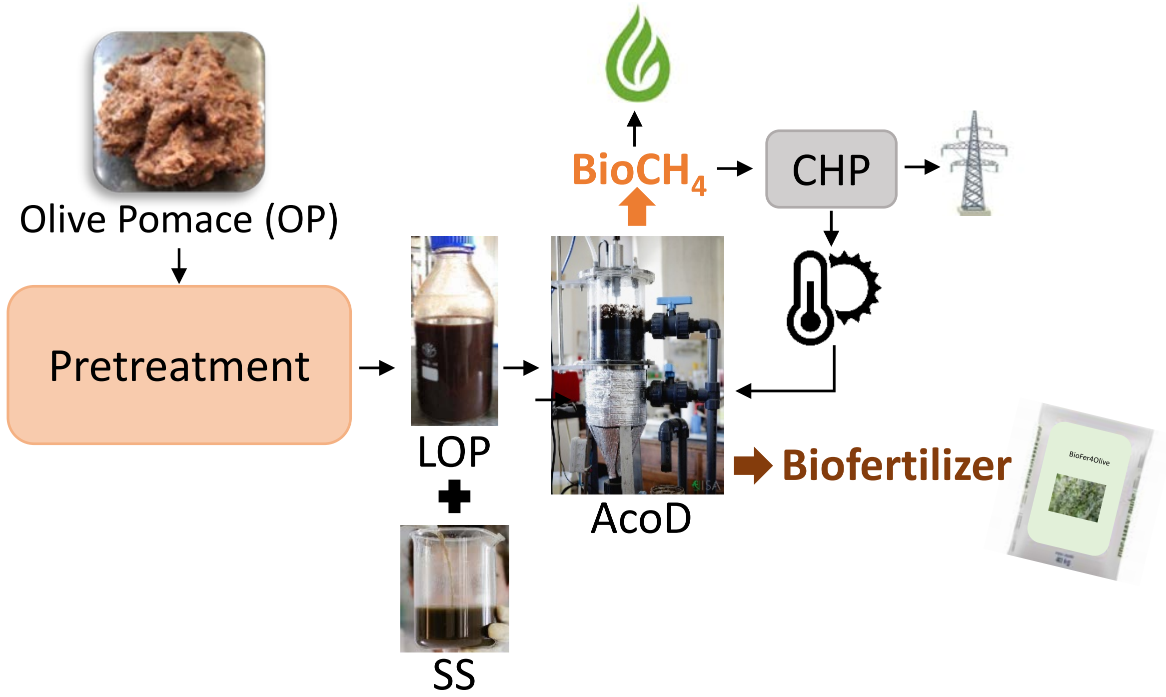
Biorefineries

Bioenergy



04
solution

one possible strategy



One solution

MATERIAL AND METHODS

Samples source and pretreatments

Olive oil mill pomace (OP)

Collected from a two-phase mill in Ribatejo (Portugal).

TS 58.95 ± 0.07%
VS 48.30 ± 0.43% (dm)
pH 4.37 ± 0.42

Sewage sludge (SS)

Collected from a WWTP with an average flow of 53,000 m^3/day (211,000 inhabitant's equivalent), located in Lisbon, Portugal.

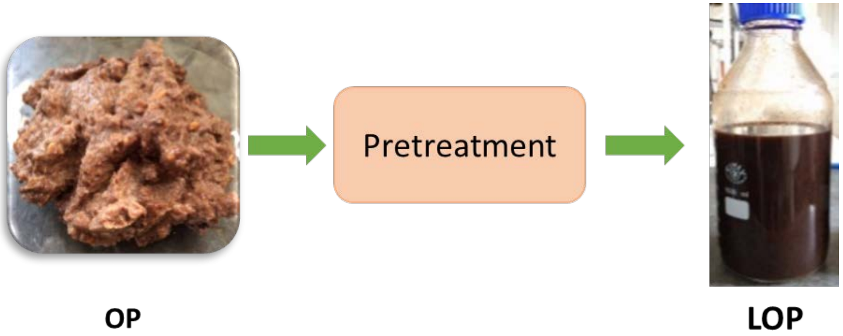
SS is a mixture of primary sludge and waste activated sludge (40:60, v:v).

MATERIAL AND METHODS

Samples source and pretreatments

OP was **pretreated by hydrolysis under alkaline conditions**

- 0.4% sodium hydroxide solution
- dried solid to liquid ratio of 1/10
- 24h contact time at **room temperature**



Liquid extract (LOP) obtained by filtration under vacuum was characterized and used for the AD

MATERIAL AND METHODS

Anaerobic digestion trials

- CSTR working volume: 11,3 L
- Mesophilic conditions (36 ± 1ºC)
- HRT 17 days

T1

Co-digestion

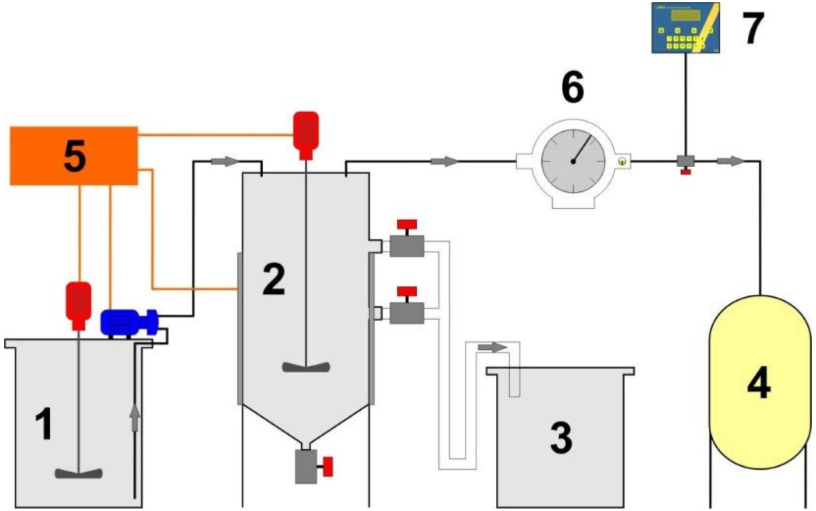
SS 80%

LOP 20%

T0

Mono-digestion

SS



Lab-scale AcoD unit: 1- Substrate mixture tank; 2- CSTR; 3- Digestate collection tank; 4 - Gas holder; 5 - Control System; 6 - Gas meter; 7 - Gas analyser

Results and discussion

Physico-chemical characterization of the feed during T0 and T1

	T0	T1
TS (gL^{-1})	18.46 ± 2.04	19.2 ± 1.8
VS (gL^{-1})	13.51 ± 1.52	16.03 ± 1.11
VS/TS (%)	73	83
pH	6.70 ± 0.4	7.3 ± 0.37
EC ($mS.cm^{-1}$)	1.51 ± 0.35	2.01 ± 0.61
TCOD ($g\ O_2L^{-1}$)	23.23 ± 3.144	29.16 ± 1.35
SCOD ($g\ O_2L^{-1}$)	1.18 ± 2.13	3.06 ± 0.11
SCOD/COD (%)	5	11
TKN (gL^{-1})	1.28 ± 0.21	1.02 ± 0.18
C/N	6	9

How LOP improved feed characteristics

Results and discussion

AD process performance

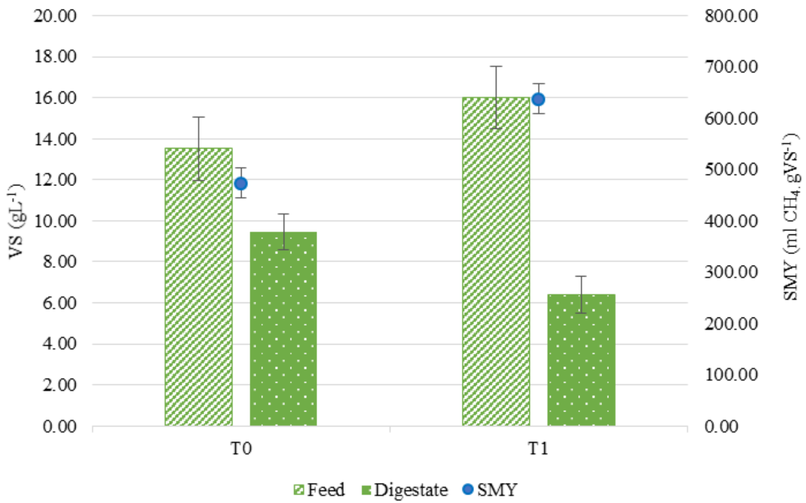
- **BPR** increased **58%**
- **SMY** increased **35%**, despite the 18% increase in OLR
- **TA** showed a **slight decrease** indicating that VFA may be accumulating (but digestate pH was 7.16 ± 0.07)

	T0	T1
OLR (g_{VS} $L^{-1}d^{-1}$)	0.80 ± 0.23	0.94 ± 0.12
BPR (mL $L^{-1}d^{-1}$)	596 ± 42	941 ± 77
Methane content (% CH_4)	63.5 ± 0.1	64.0 ± 0.2
SMY (mL_{CH4} g_{VS}^{-1})	474 ± 29	638 ± 31
SELR (d^{-1})	0.14	0.19
TA (mg $_{CaCO3}$ L^{-1})	3200 ± 95	2762 ± 133

BPR-biogas production rate; OLR-Organic loading rate; SMY-Specific methane yield; SELR - specific energy loading rate

Results and discussion

AD process performance



Along with the **35%** increase in **SMY**…

Average of **60% VS removal** in T1

VS

30% VS removal in T0

Improved bioconversion

Results and discussion

Reactor stability

- **Specific Energy Loading Rate (SELR)** values were kept **< 0.4 d^{-1}** indicating **reactor stability**

- **SELR** values (0.14; 0.19) suggest that **LOP % can be increased** without compromising reactor stability (but careful monitoring should be done)

$$SELR = Q \times [TCOD] / [VSS] \times V$$

Q - inlet flow rate ($L\ d^{-1}$)
[TCOD] - feed's total COD concentration ($g\ L^{-1}$)
[VSS] - digestate's volatile suspended solids concentration ($g\ L^{-1}$)
V - reactor's working volume (L)

Conclusions

AcoD of SS and LOP can be a strategy for bioenergy recovery from biowaste

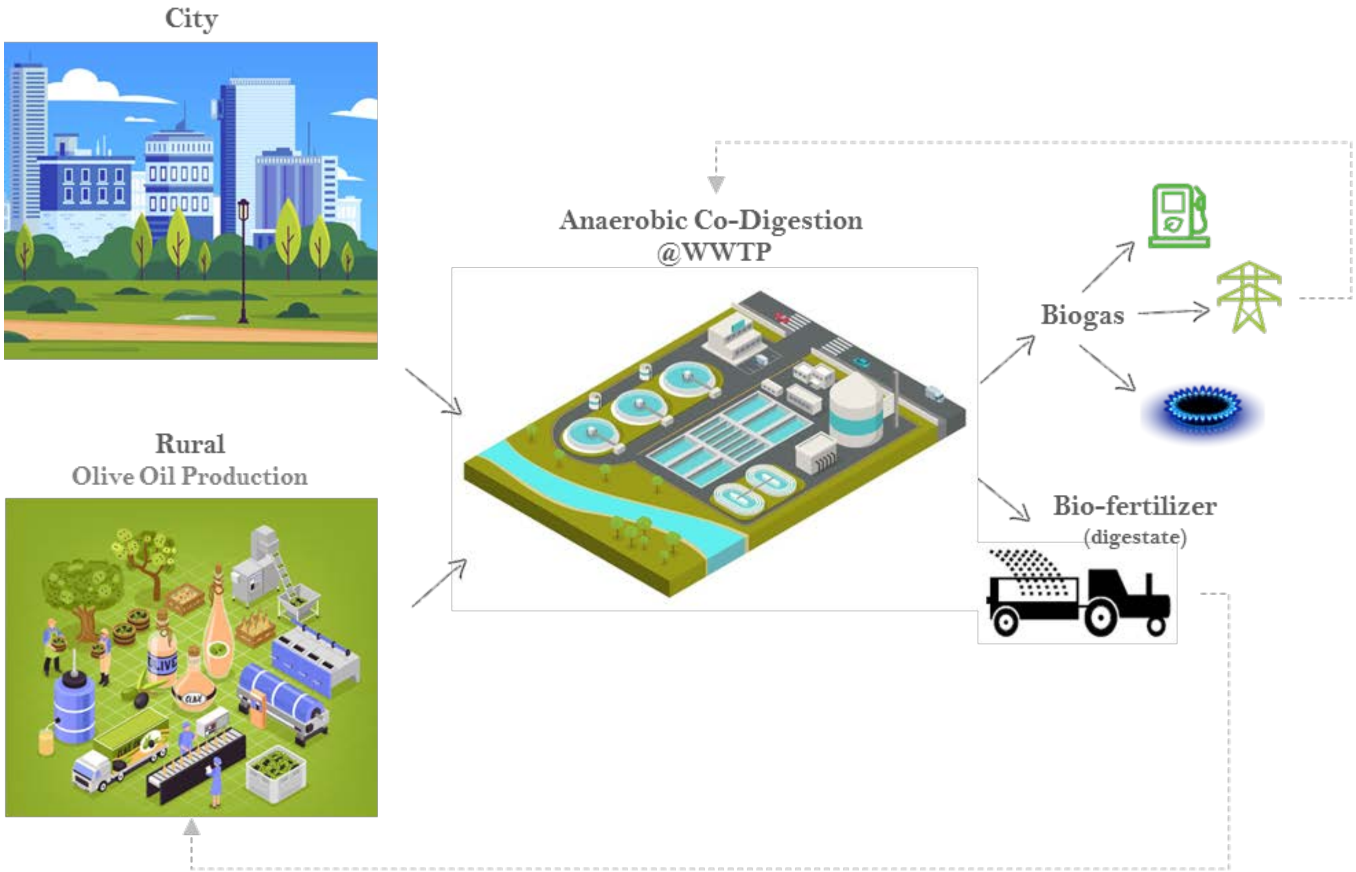
Enhanced process, overcoming SS low biodegradability, a bottleneck for its AD

Process stability was not compromised by LOP phenolics but careful monitoring should be done

Energy balance and process economics should be addressed

Conclusions

Promoting Rural-Urban Symbiosis



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THANKS

Do you have any questions?

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LEAF
LINKING LANDSCAPE, ENVIRONMENT, AGRICULTURE AND FOOD

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