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Solid Waste Management**

**Utilization of Landfill Leachate for the
Production of Oleaginous Yeast *Y. Lipolytica***

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OBJECTIVES OF THE STUDY

- To assess the potential of landfill leachate (LL) for the production oleaginous yeast *Y. Lipolytica*.
- To identify the potential of oleaginous lipid production in LL.
- Integrability of oleaginous yeast sp. to pre/post treatment.
 - To determine the removal efficiencies of COD, N, P.

▶ INTRODUCTION

- Landfill Leachate (composition, age of LL, treatment)
- Oleaginous Yeast *Y. lipolytica*
- Literature Background (species cultivation in LL)

▶ EXPERIMENTAL APPROACH

▶ RESULTS

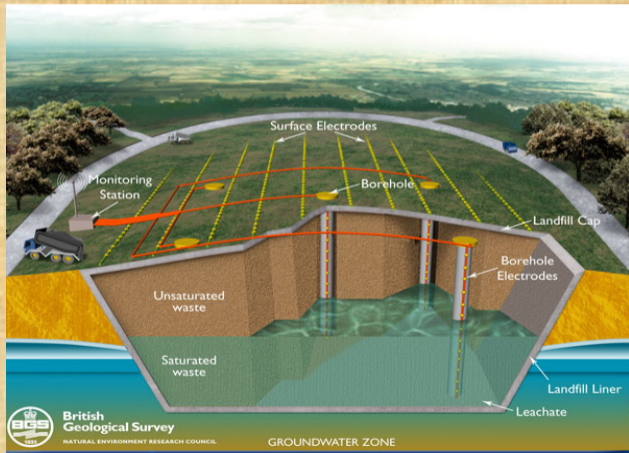
- Growth optimization of *Y. lipolytica*
- Lipid production, biomass composition

▶ CONCLUSION

INTRODUCTION

Landfill Leachate

- ▶ Effluent produced by;
 - the rainwater percolation through the waste layers
 - the biochemical processes occurring in the landfill body and
 - the intrinsic water content.



Composition of Landfill Leachate

- Inorganic, natural and xenobiotic compounds.
- Organic matter (biodegradable and refractory), chlorinated organics.
- Ammonia nitrogen
- Heavy metals, inorganic salts
- Immiscible liquids (Oils)
- Small particulates.
- A range of organisms (bacteria, virus)



A landfill leachate treatment site

Classification of LL according to Age

	Young	Medium	Old
Age	<5	5-10	>10
pH	<6.5	6.5-7.5	>7.5
COD	>10,000	4,000-10,000	<4,000
BOD5/COD	>0.3	0.1-0.3	<0.1
Heavy metals	>2.0	<2.0	<2.0
Organics	80% VFA	5-30% VFA + humic and fulvic acids	humic and fulvic acids
Biodegradability	High	Medium	Low

Renou et al. 2008; Abbas et al. 2009

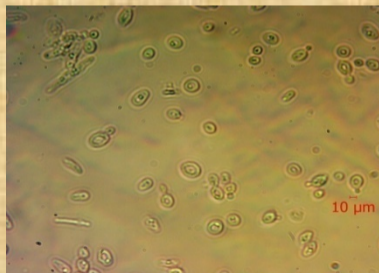
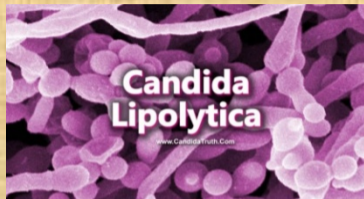
Treatment Methods of Landfill Leachate

Treatment	Age of LL		
	Young	Medium	Old
Channeling Combined with domestic sewage	Good	Fair	Poor
Recycling	Good		
Biological (Aerobic, Anaerobic)	Good	Fair	Poor
Physico/chemical			
Coagulation	Poor	Fair	Fair
Precipitation	Poor	Fair	Poor
Adsorption	Poor	Fair	Good
Oxidation	Poor	Fair	Fair
Striping	Poor	Fair	Fair
Membrane filtration			
Microfiltration	Poor	–	–
Ultrafiltration	Poor	–	–
Nano	Good	Good	Good
Reverse Osmosis	Good	Good	Good

Oleaginous Yeast *Yarrowia Lipolytica*

- ▶ *Y. lipolytica* is a dimorphic, non-pathogenic ascomycetous yeast.
- ▶ Oil feedstock for alternative sustainable fuels sources
- ▶ High-oil yeast up to 70% of lipids by dry cell weight.

- ▶ Environments of hydrophobic substrates
 - Dairy products
 - Oily waste
 - Soils contaminated with oils
 - Marine sediments
 - Wastewaters



Literature Background

- 1) **Energy crops**¹ (sunflower, soybean, rapeseeds)– phytotreatment
- 2) Ascomycete fungi *Lambertella sp.*² – TOC removal 90%
- 3) Fungal strain³ – bioremediation
- 4) **White–rot basidiomycete *Trametes trogii***⁴ – reduction of phenols, N, hydrocarbons
- 5) **Photosynthetic bacteria**⁵ *R. Palustris*

1: PhD thesis, Garbo, 2018. 2: Siracusa et al. 2020. 3: Spina et al.2018. 4 – Smaoui et al., 2019 5 – Wang et al. 2018

EXPERIMENTAL APPROACH

LL used in the study

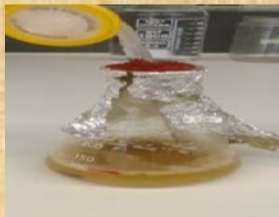


Fermentation of samples at 28°C in shake flask.



Experimental Approach

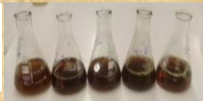
Y. Lipolytica Seed Culture



YPD Media
Yeast extract
Peptone
D-glucose

Growth Optimization in Batch LL Samples

LL Conc.
(50–100%)



Phosphorous,
Yeast Extract



Glucose



Analysis of Biomass

- VSS
- Lipid
- Carbohydrate
- Protein
- COD, N, P

RESULTS

- ▶ **Characterization of LL**
- ▶ **Growth Optimization of *Y. Lipolytica* in LL**
 1. **Concentration of LL (50-100%)**
 2. **Nutrient Supplement**
 - **Phosphorous (0.25-1000mg/L)**
 - **Yeast Extract (100,1000,10,000 m/gL)**
 - **Carbon Source (C/N Ratios of 5, 50, 100, 125)**
- ▶ **Lipid yields from *Y. lipolytica* Biomass**

Characterization of Landfill Leachate

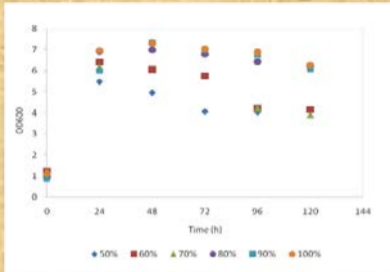
	Raw	Raw Autoclaved
pH	8.3	9.8
Conductivity (mS/cm)	35.5	-
Alkalinity(gCaCO₃/L)	-	10.5
SS (mg/L)	852	791
VSS (mg/L)	751	713
TCOD (g/L)	11.2	11.2
sCOD (g/L)	10.9	11.2
TKN (g/L)	3634	2470
NH₃-N (g/L)	2920	1960
TP (mg/L)	100	100
Ortho P (mg/L)	3.7	3.9

Growth Optimization of *Y. Lipolytica* in LL

Optical Density

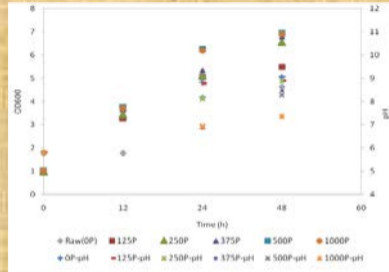
A) LL Conc
120 h.

OD max:
7.5



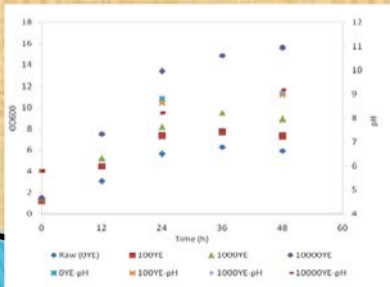
B) Ortho P
48 h.

OD max:
9



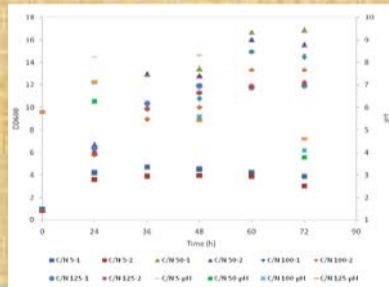
C) Y.E.
48 h.

OD max:
16

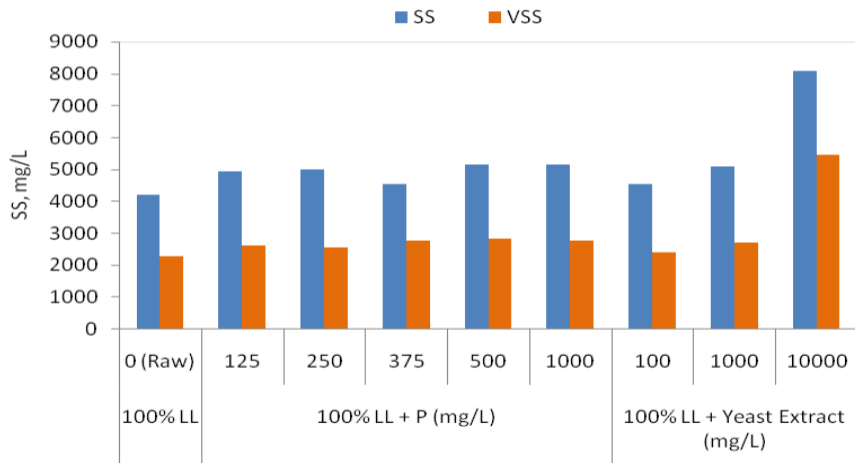


D) C/N Ratio
72 h.

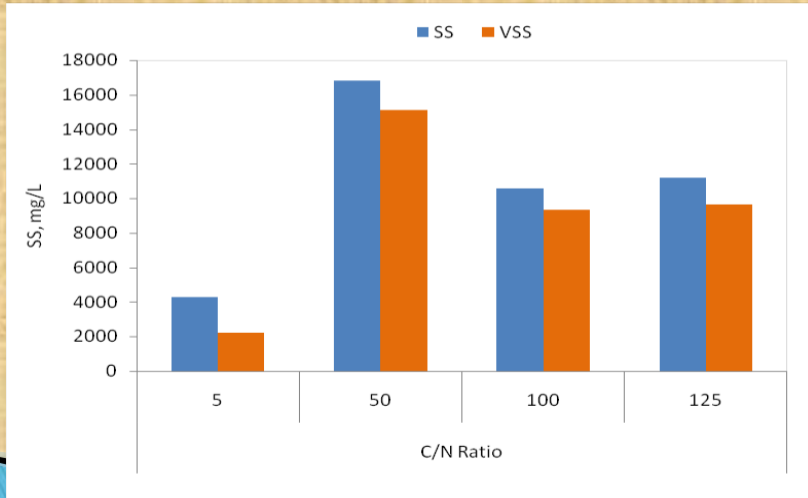
OD max:
17



Growth Optimization of *Y. Lipolytica* in LL Biomass Production (P, Y.E. Addition)

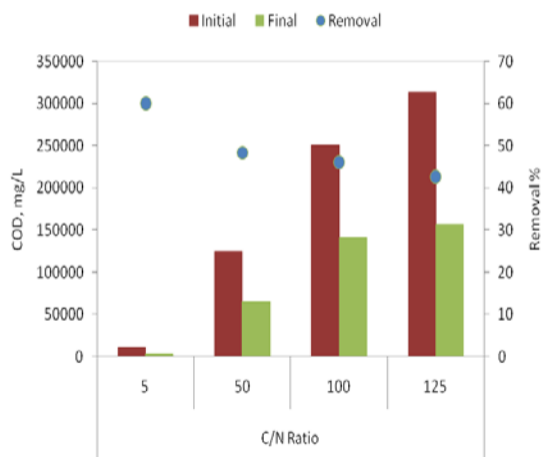
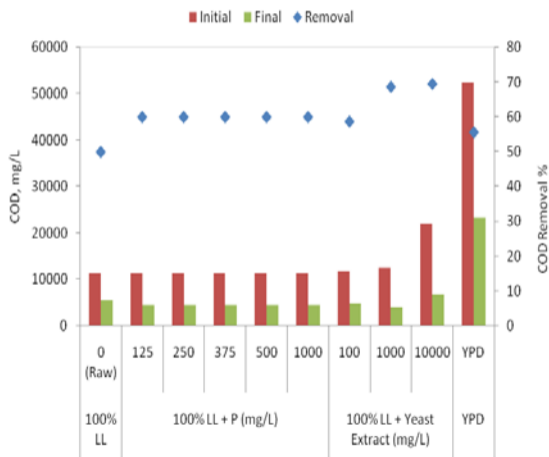


Growth Optimization of *Y. Lipolytica* in LL Biomass Production (Glucose Addition)

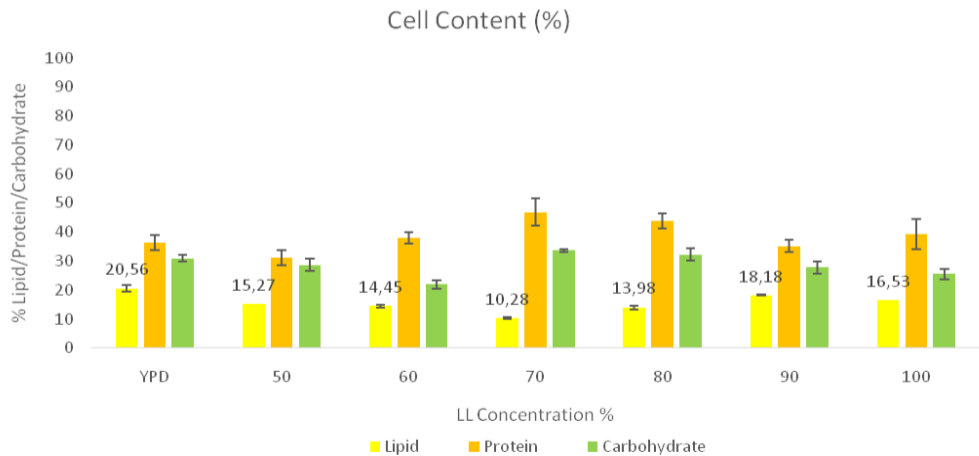


Growth Optimization of *Y. Lipolytica* in LL

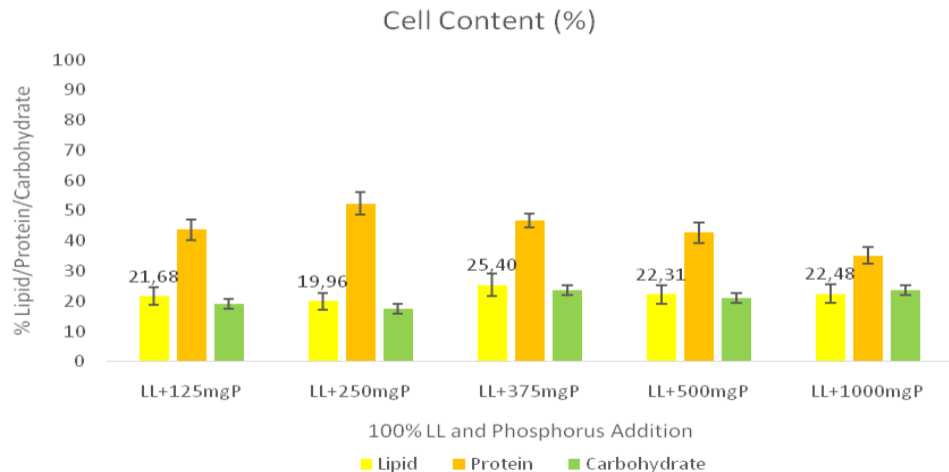
COD Removal



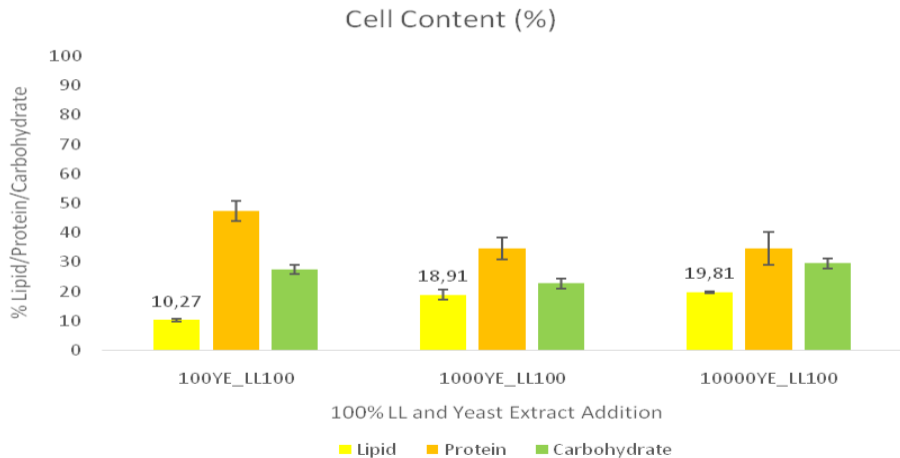
Lipid Production of *Y. Lipolytica* in LL (Concentration of Raw LL)



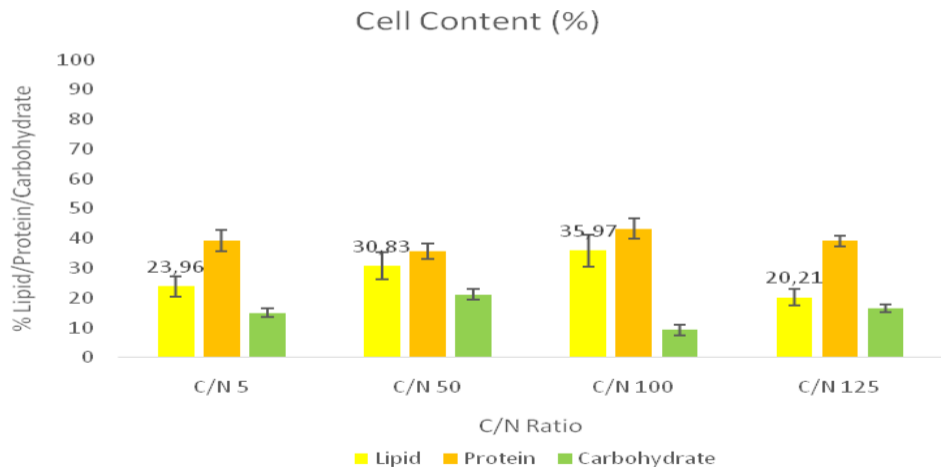
Lipid Production of *Y. Lipolytica* in LL (P Addition)



Lipid Production of *Y. Lipolytica* in LL (Y.E. Addition)



Lipid Production of *Y. Lipolytica* in LL (Glucose Addition - C/N Ratio)



CONCLUSION

Conditions of the Study	Max. Biomass Productivity (mgVSS/L)	Max. Lipid Productivity (wt%)
Concentration	100% Raw LL (2.2)	90% LL (18.2)
Phosphorous +LL	125 mg/L P (2.6)	375 mgP /L (25.4)
Yeast Extract +LL	10 g/L Y.E (5.5)	10 g/L Y.E (19.8)
C/N Stress	C/N 50 (15.1)	C/N 100 (36)
YPD Media	(10.4)	(20.6)

CONCLUSION

- ▶ *Y. lipolytica* in 100% LL can be improved with carbon and phosphorous addition.
- ▶ C/N 50 – the best condition to maximize both biomass and lipid yield above 30%.
- ▶ Promising in revaluation of landfill leachate and obtaining valuable microbial products.

Acknowledgements

The authors acknowledge the support from “The Scientific and Technological Research Council of Turkey” for the Oleaginous Yeast Project (TUBITAK -115Y349).

A scenic view of a rocky coastline with turquoise water and a boat in the distance. The foreground shows a sandy beach with shallow, clear water. The middle ground features a rocky shore with some greenery. In the background, a boat is visible on the water, and mountains are visible on the horizon under a blue sky with some clouds.

Thanks for your interest