National Technical University of Athens
Unit of Environmental Science and Technology

CHANIA2023
21-24 JUNE
10th International Conference on Sustainable Solid Waste Management

Turning urban biowaste in bioethanol in pilot scale

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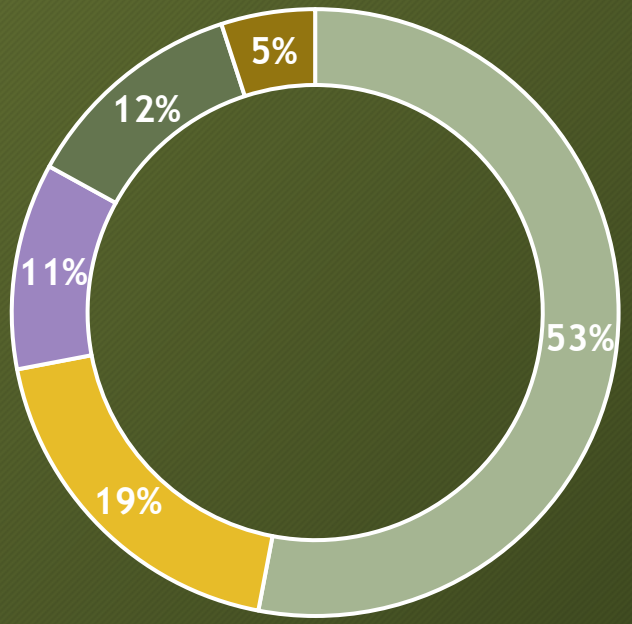
Contents

Household Food Waste

Biowaste: 34% of municipal solid waste in Europe

- Environmental Impact
- Economic Impact
- Social Impact



Household food waste represents 60% of total bio-waste.

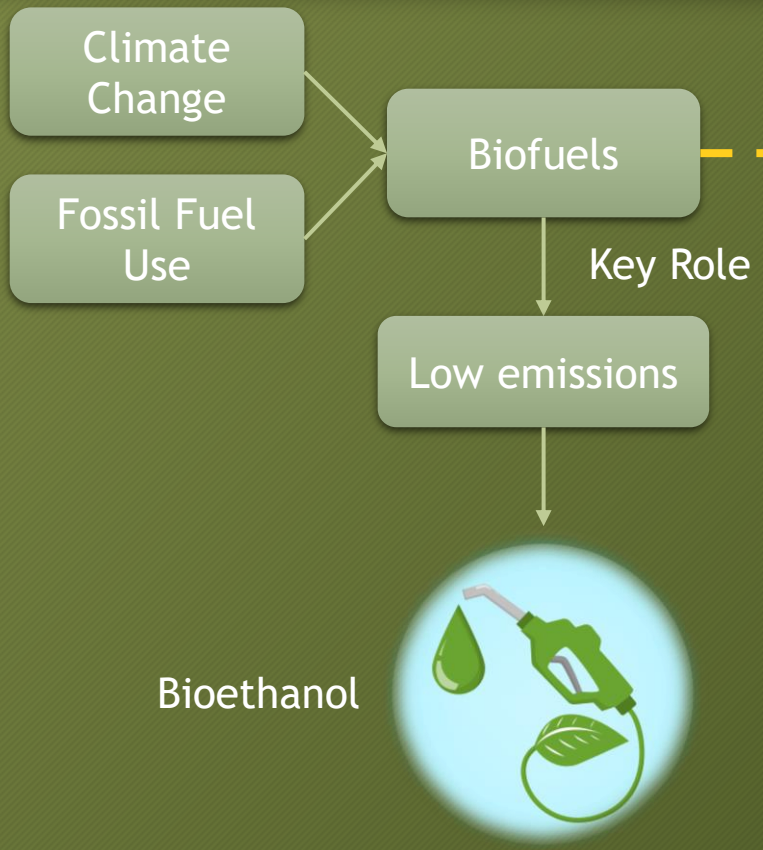
Source separated household food waste

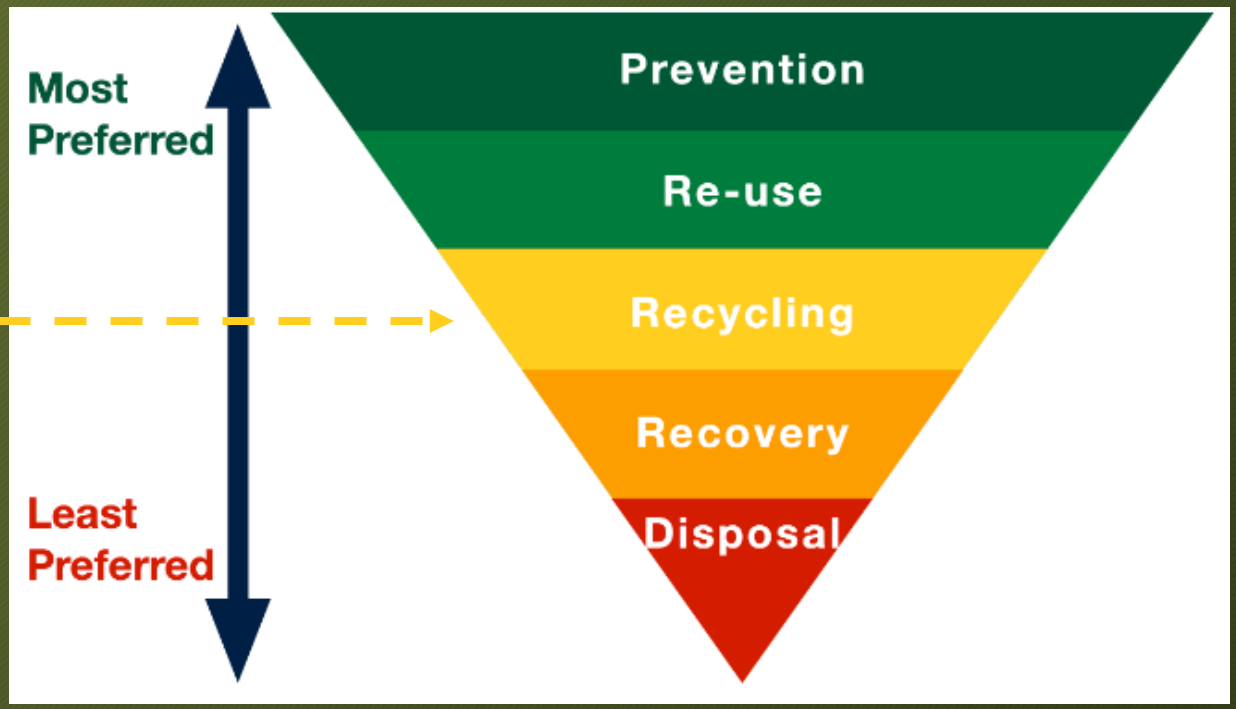
Demand for high value-added products:

Sorting at source → Legislative framework :

- ✓ Integrated
- ✓ Coordinated

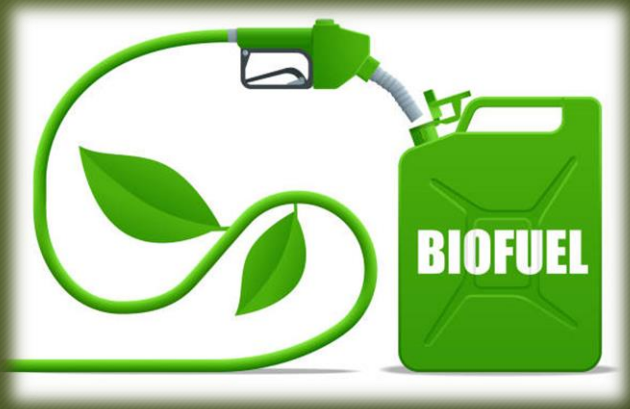
Food waste management hierarchy





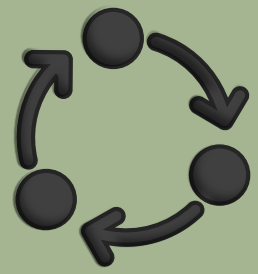
Aim of the research

Investigation of bioethanol production from source separated food waste rich in carbohydrates, fats and proteins as received



Substrate rich in carbohydrates → (Enzymes) Glucose → (S.cerevisae) Bioethanol

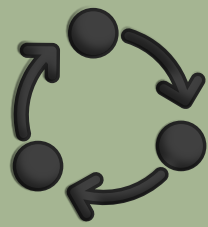
Materials & Methods



Feedstock Origin

- ✓ Transport
- ✓ Delivery
- ✓ Delivery Frequency: every 15 days
- ✓ Delivered Quantity ∽ 100 kg

Feedstock Characterization



Trial	Moisture (%)	Free Glucose (%w/w d.b.)	Starch (%w/w d.b.)	Cellulose (%w/w d.b.)
1	77,13	1,29	4,30	10,45
2	77,13	1,29	4,30	10,45
3	87,00	6,45	1,51	8,59
4	78,16	5,04	3,02	4,29
5	86,14	1,13	10,85	10,93
6	87,91	1,20	2,90	8,00
7	84,54	0,96	4,93	9,52
8	83,07	3,08	2,13	8,19
9	80,32	0,24	11,94	8,00
10	82,79	1,47	4,26	11,52
11	78,39	2,14	6,87	11,06
Mean Value ± Standard Deviation	**82,05 ± 4,04**	**2,48 ± 2,30**	**4,46 ± 2,78**	**9,35 ± 1,13**

Experimental Procedure

Experimental Conditions

Feedstock Pretreatment

Shredder Bowl Cutter LFC-18V2

Fresh Food Waste

Moisture ~ **75%**

15 min milling and homogenization per 15kg of fresh biowaste

Milled and Homogenized Food Waste

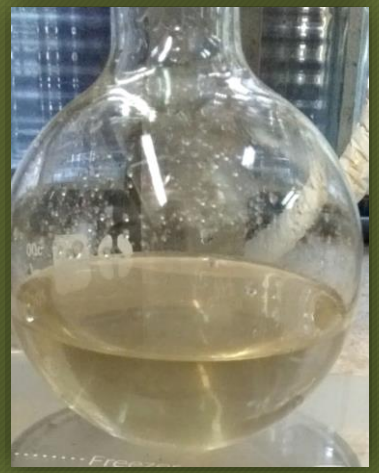
Moisture ~ **75%**

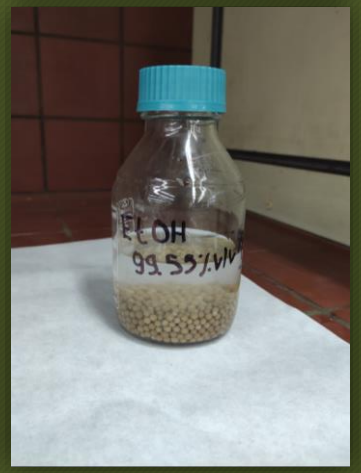
Pilot Unit (Hydrolysis-Fermentation)

Characteristics:

- Two rotating vessels
- Double walls
- Temperature control with water
- Controlled by PLC

Pilot Unit (Distillation-Dehydration)





Distillation Unit:
- 70 ^{o}C
- Vacuum Pump

1st Distillate:
35 % v/v

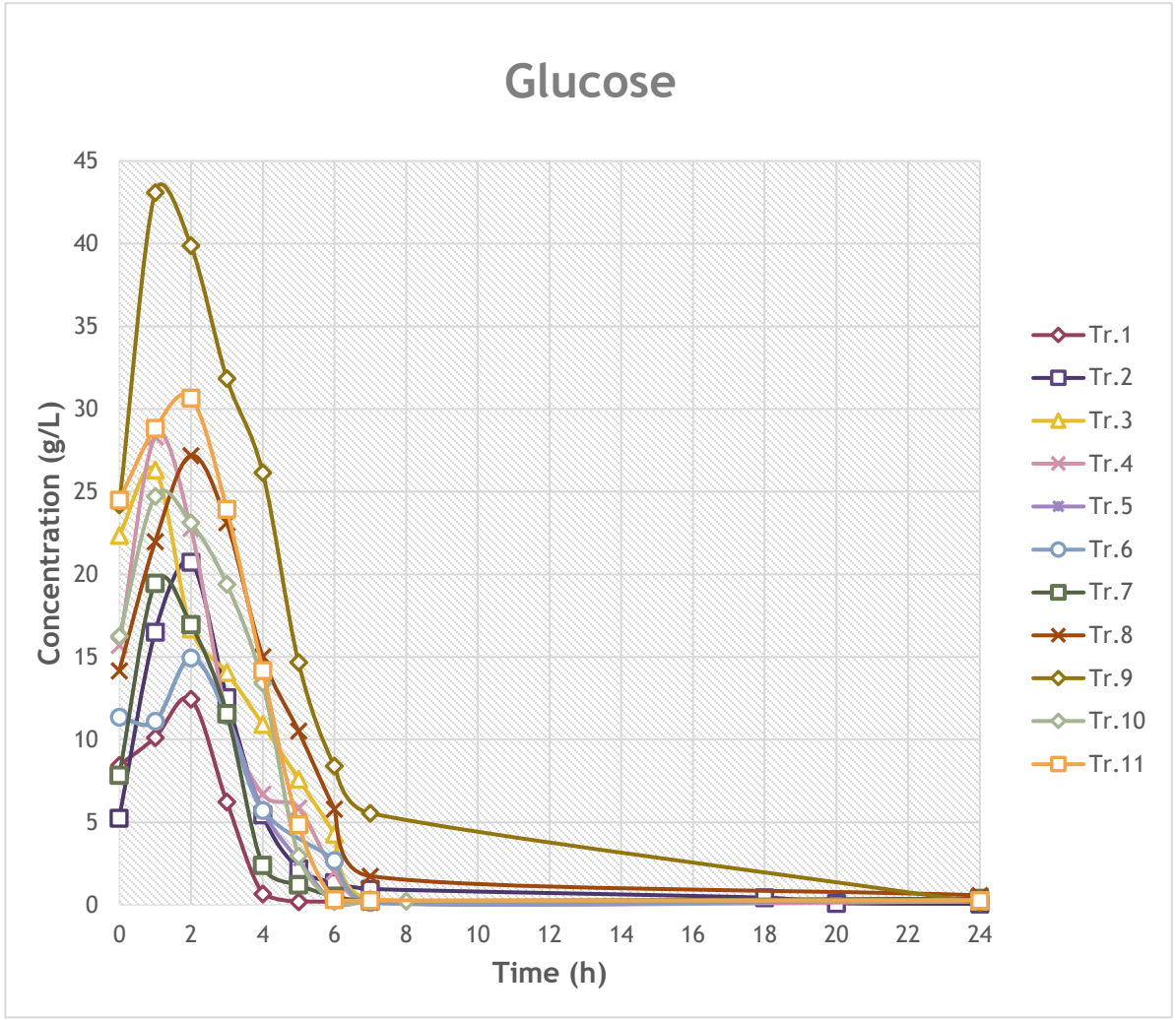
Lab-scale two stage distillation:
94-95 % v/v

Zeolite 3A:
99.55 % v/v

Results & Discussion

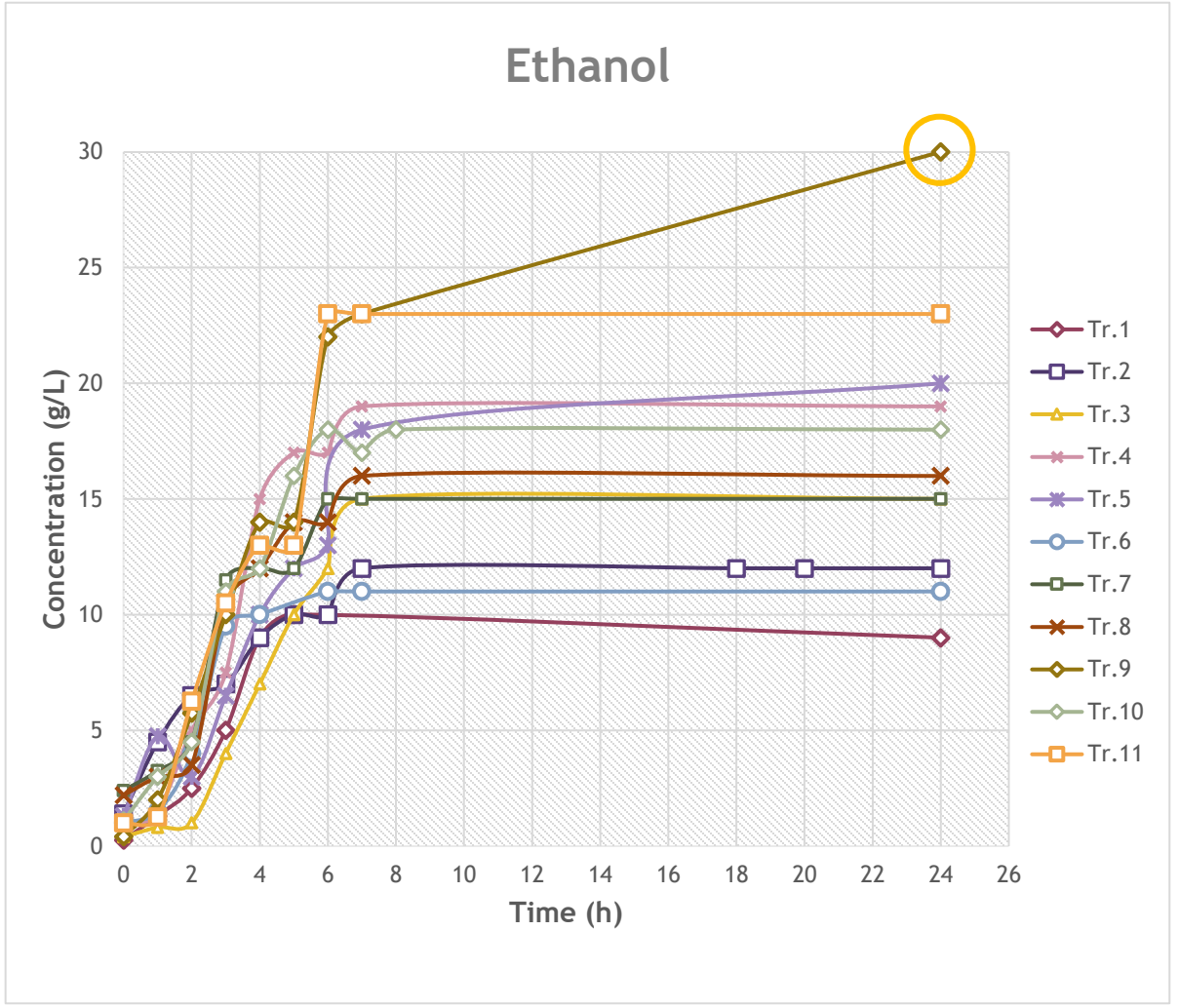
Experimental Trials (1/2)

- 11 Experimental Trials
- Steady Dosage of Yeast and Enzymes

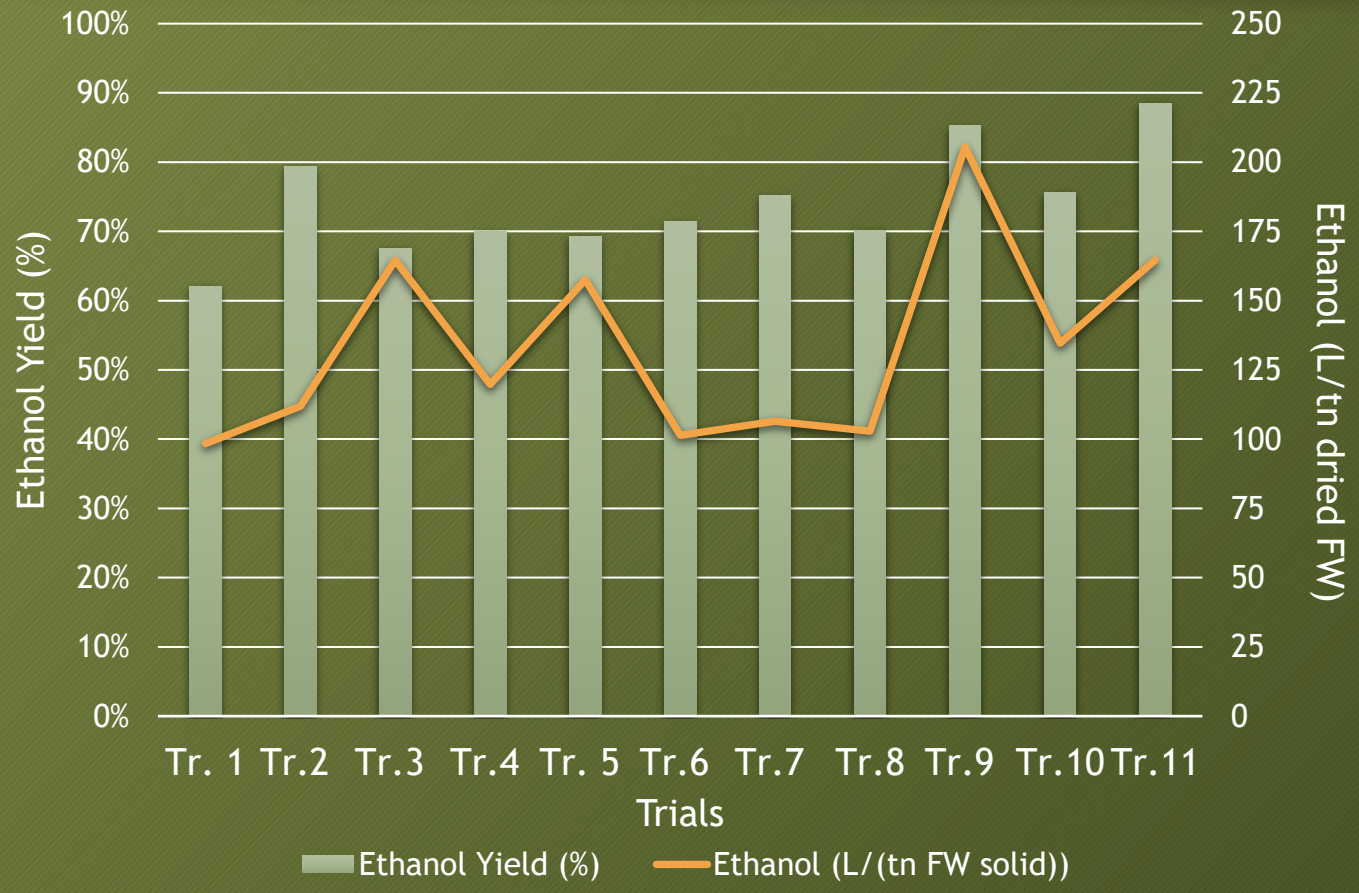


Experimental Trials (2/2)

- Maximum Ethanol concentration 30 g/L

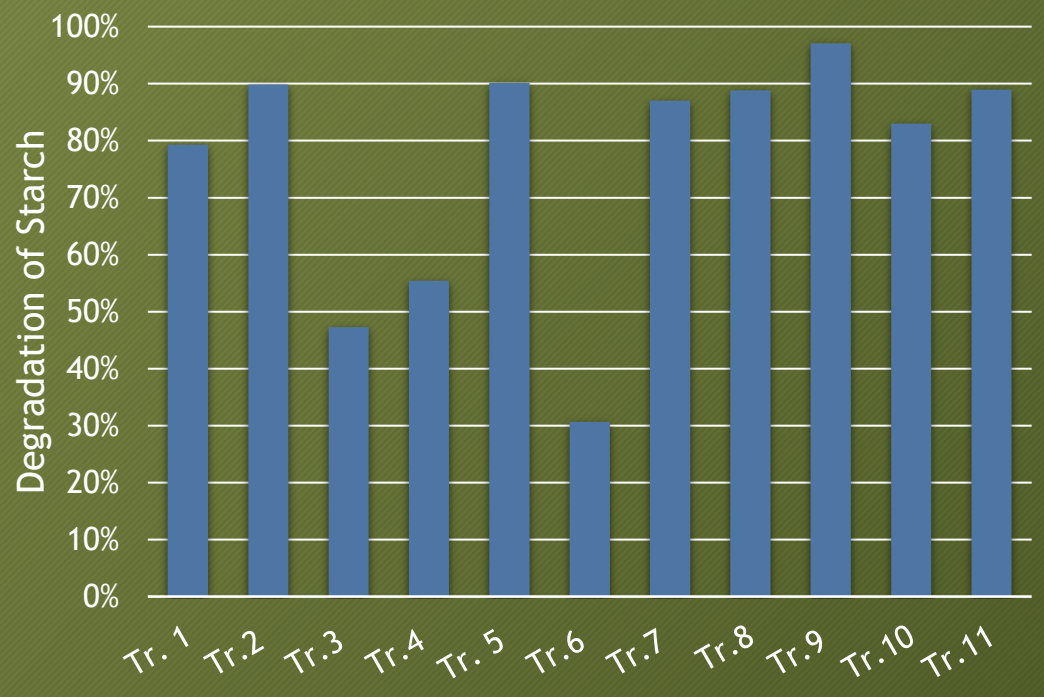


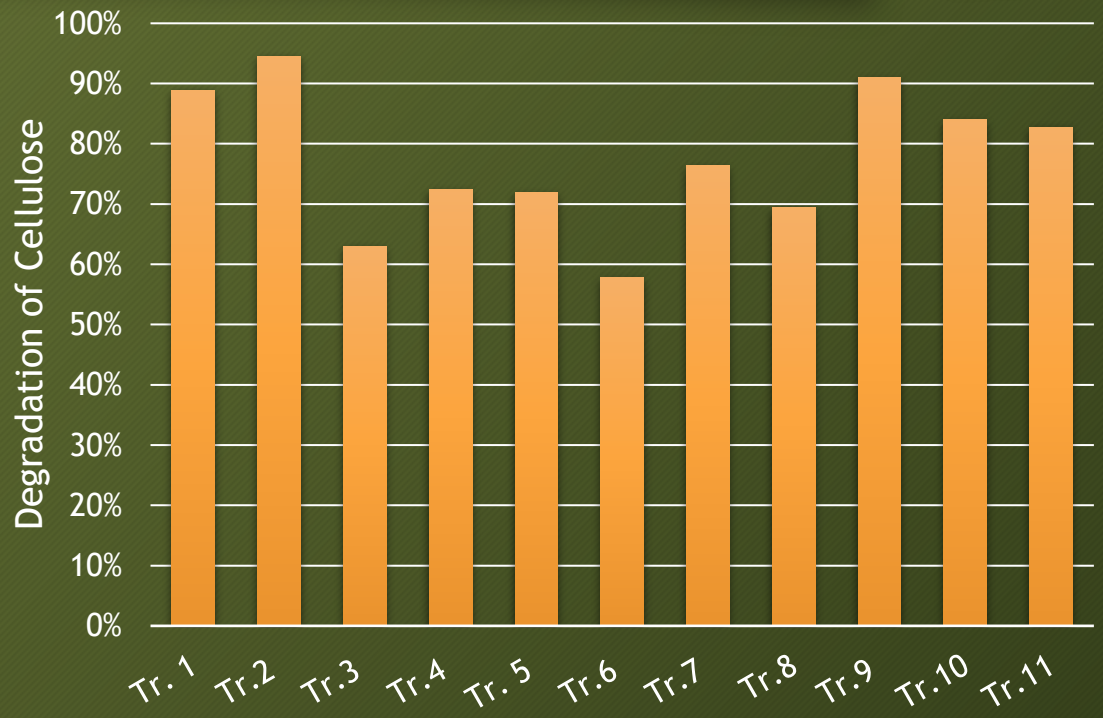
Ethanol Yield



Ethanol (L/tn dried FW)	133.42 ± 33.42
Ethanol yield (%)	74.05 ± 6.82

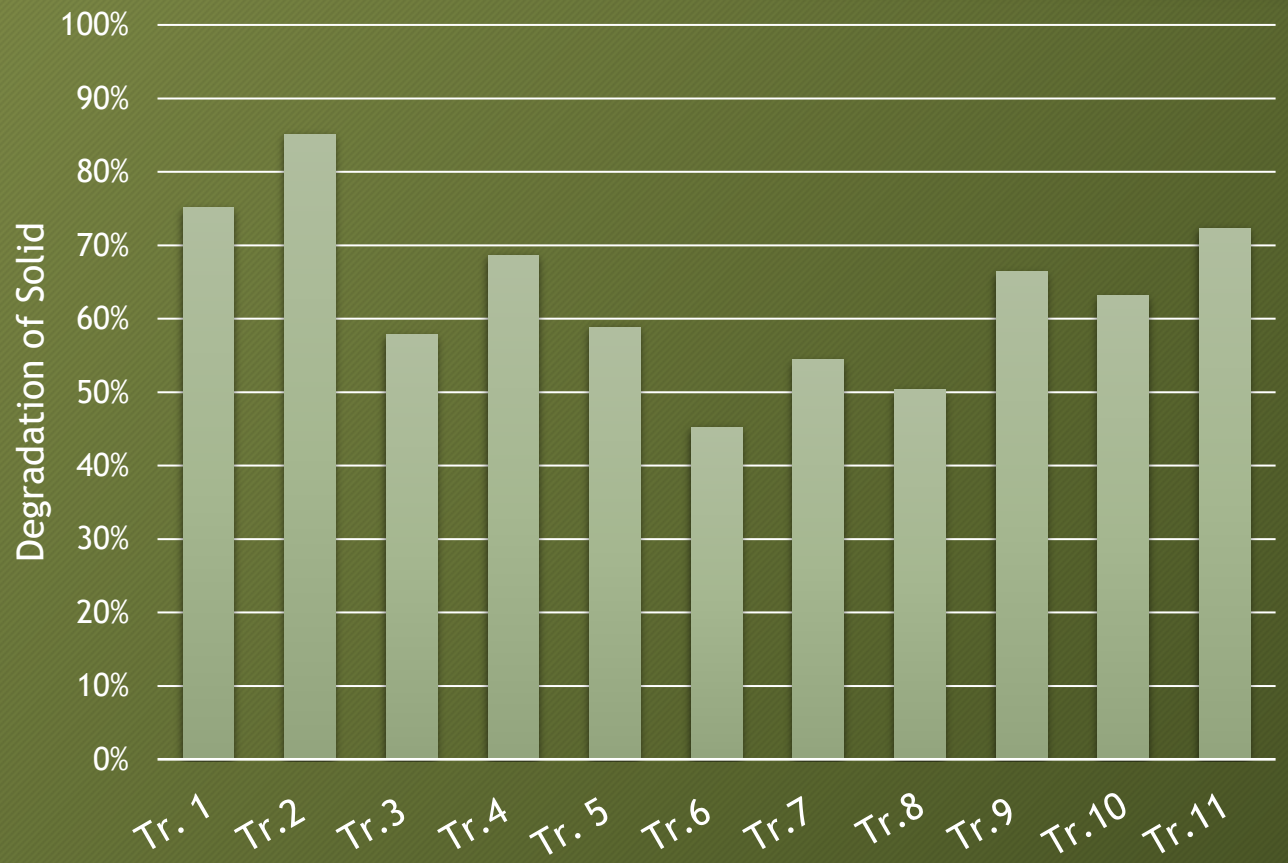
Degradation of Starch and Cellulose





	Mean Value
Degradation of Starch(%)	76.15 ± 23.46
Degradation of Cellulose (%)	77.45 ± 12.77

Degradation of Solid



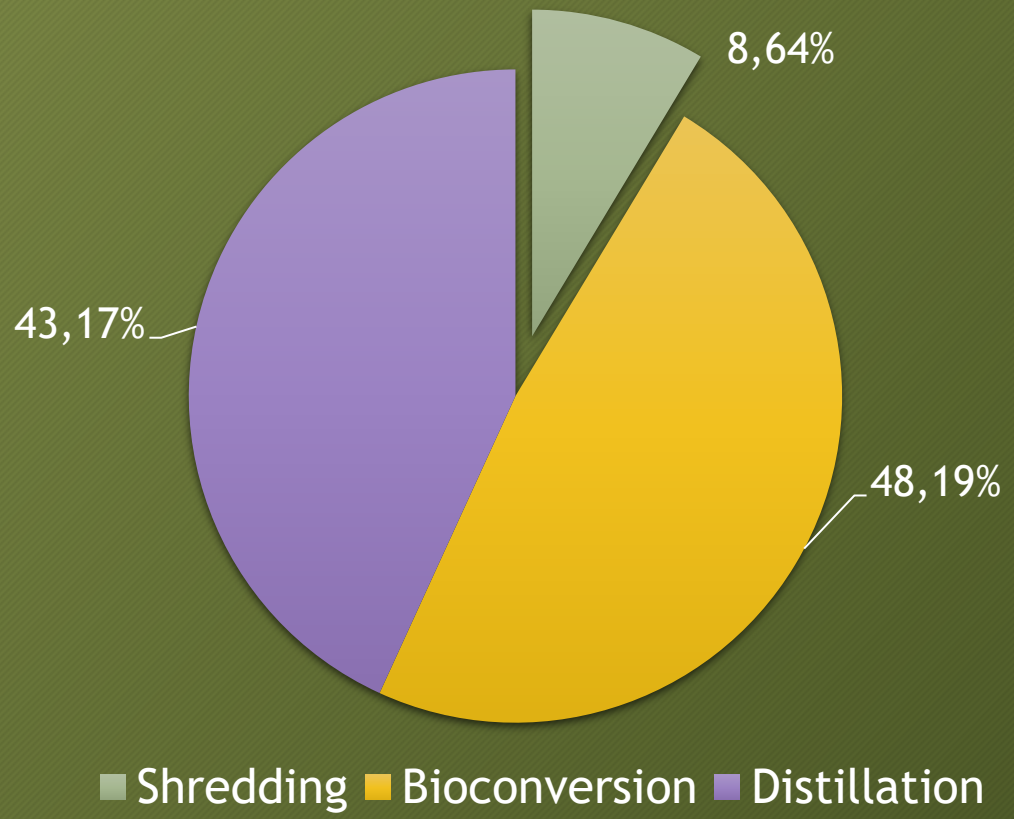
Degradation of Solid (%)	63.40 ± 12.60

Energy Consumption

Main stages of the process :

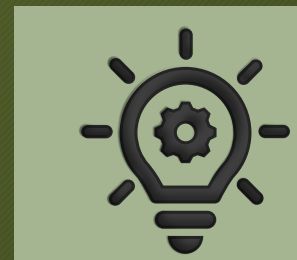
- Shredding
- Simultaneous Saccharification and Fermentation process
- Final recovery of produced ethanol via distillation

Energy Consumption



- 2.17kWh per kg of dried feedstock
- 0.52kWh per kg of wet feedstock
- 16.07 kWh per L of ethanol produced

Conclusions



Promising yields with the use of wet feedstock

High degradation efficiencies of starch and cellulose

WaysTUP!

VALUE CHAINS FOR DISRUPTIVE TRANSFORMATION OF URBAN BIOWASTE INTO BIOBASED PRODUCTS IN THE CITY CONTEXT

Thank you !

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