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of Patras

## Improved biogas production from sewage sludge by co-digestion with the organic fraction of municipal solid waste

Angeliki Maragkaki Mineral Resources Engineer, MSc Solid Waste & Wastewater Manager Laboratory TEI of Crete

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## EU Directive

# Introduction

#### Municipal solid wastes in Greece



# Anaerobic digestion

#### The Biochemistry

## 1 Hydrolysis

Complex organic molecules to soluble

### 2 Acidogenesis

Small organic molecules to fatty acids

## 3 Acetogenesis

Conversion to acetic acid & CO<sub>2</sub>

## 4 Methanogenesis

Final conversion to methane [CH<sub>4</sub>]



# Co - digestion

Factors impact the production of biogas

- ✓ The type of waste being digested✓ Its concentration
- ✓ Its temperature (35-40°C or 55-60°C)
- ✓ The presence of toxic materials
  ✓ The pH (~7.0) and alkalinity
- ✓ The hydraulic retention time (15-35 d)
- $\checkmark$  The solids retention time
- $\checkmark$  The ration of food to microorganism
- $\checkmark$  The rate of digester loading
- ✓ The rate at which toxic end products of digestion are removed



Manure

# **Co - digestion**

Co – digestion of two or more materials
✓ Improves feed characteristics
✓ Increases biogas production
✓ Improves effluent quality



# **Research Purpose**

In existing biogas digester treating Sewage sludge



# Feedstock









**50% cooked food** (10% meat, 15% potatoes, 20% rice and 5% others) **20% raw-fresh food** (vegetables) **10% fruits** 

10% fruits 10% salads 8% bread 2% dessert



# **Experimental procedure**

- ✓ 100% sewage sludge (SS)
- ✓ 5% food waste (FW) and 95% sewage sludge (SS)
- ✓ feeding volume **125ml** daily
- ✓ Initial feed sewage sludge for **30 days**

SS SS+FW







# Results

Significant Acidic → decrease mixture

Characteristics of experimental materials as feedstock

Parameters	SS	FW O	SS + FW
pН	$7.3 \pm 0.3$	4.2 ± 0.1•	6.2 ± 0.2
TS (g/l)	30.5 ± 2.1	122.6 ± 4.0	39.0 ± 14.4
VS (g/l)	20.7 ± 1.6	$107.0 \pm 4.7$	$25.0 \pm 5.9$
t-COD (g/l)	44.2 ± 13.5	151.3 ± 10.0	52.7 ± 10.7
d-COD (g/l)	1.8 ± 0.6	$75.0 \pm 3.9$	5.3 ± 1.4



## Results



# Conclusions

✓ Co-digestion process of sewage sludge with food waste can be implemented in existing wastewater treatment plants

 ✓ A 5% addition of food waste to sewage sludge increased biogas production 220% (312ml/l/d) compared to sewage sludge alone
 ✓ Methane can be produced very efficiently by codigesting sewage sludge and food waste

# **Next Steps**

✓ A 10% and 15% addition of food waste will examined in subsequent experiments



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