Anaerobic co-digestion of pig manure with fruit wastes –

Process development for the recycling in decentralised farm scale plants

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Presentation structure

➢ Framework of the research

➢ Objectives

➢ Introduction

➢ Methods

➢ Results and Discussion

➢ Conclusions

Research Framework

- ➢ PhD project :
    - First year of a 3 years program.
    - To study the co-digestion of biowaste with pig manure.

- ➢ Demonstration project :
    - Second year of a 3 years project.
    - To demonstrate in a pig farm, the operation of decentralised co-digestion processes using a pilot plant.

Objectives

➢ To study the utilization of fruit wastes (FW), rejected from centralised fruit storage and distribution facilities of producers, as a co-substrate for co-digestion with pig manure (PM) in farm scale digesters.

- Biogas production
- Fruit wastes pre-treatment and handling
- Process stability

Introduction

Some caracteristics of the local agriculture economy:

- Strong pig production activity

- Intensive fruit production with storage and distribution facilities.

Atlantic Ocean

Alcobaça

Braga

Porto

Aveiro

Coimbra

Covilhã

Portalegre

Lisboa

Beja

Faro

Spain

Methods

➤ **Origin of materials**

FW – Selection and rejection processes. Mixture of apples and pears.

PS – Screened pig slurry from a farrow-to-finish pig farm

Methods

➤ **Mechanical pre-treatment**

FW – Pulped

Methods

> Mixture PS+FW before digestion

Methods

- ➢ **Laboratory set up**

- • Batch trials

  2 l glass reactors

  T – 37ºC

  50 days

Methods

➤ **Laboratory set up**

- Continuous trials

Stainless steel CSTR

Vr – 11l

T – 37ºC ± 4ºC

Results and discussion

➢ Caracteristics of the waste materials

		Pig slurry A	Pig slurry B	Fruit waste pulp
pH		7.77	7.42	3.49
TS	g/l	14.72	38.91	157.58
VS	g/l	10.00	28.48	154.17
Crude Fibre	g/l	2.53	-	13.97
Crude Fat	g/l	0.42	-	0.45
COD	mg O_2/l	16398	-	186960
COD soluble	mg O_2/l	8707	-	166050
TK-N	g/l	1.78	-	0.461
NH_4^+-N	g/l	1.04	-	0.110
T-P	mg/l	342.92	-	65.49

Results and discussion

➤ **Biogas production rate at different OLR**
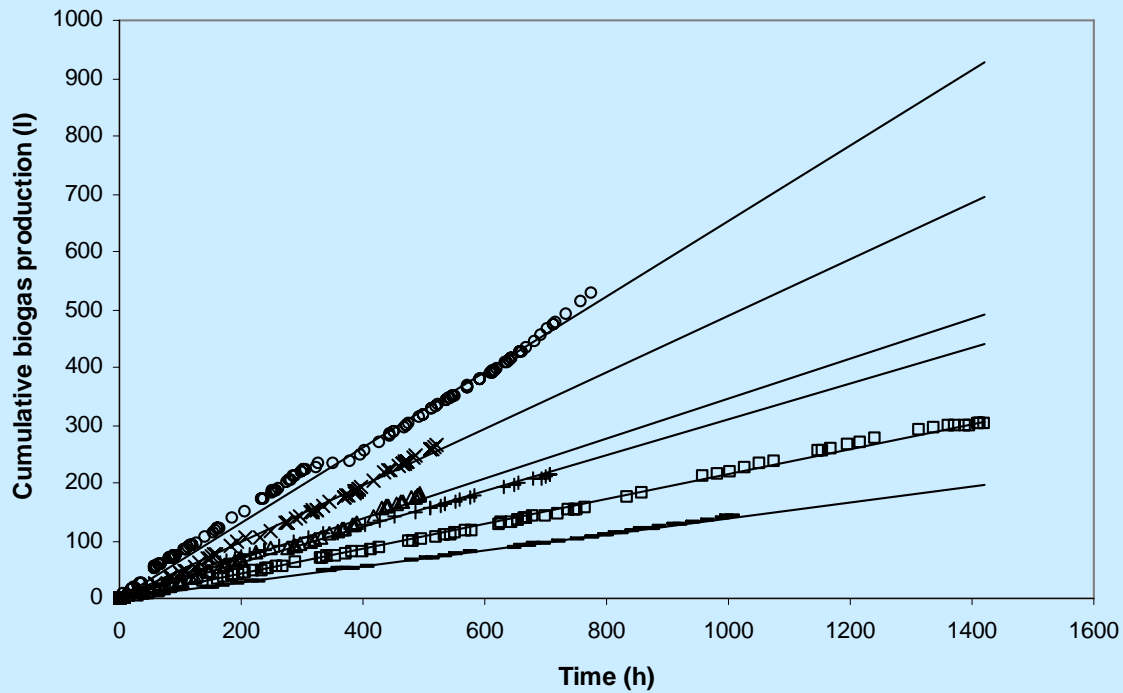
Results and discussion

➢ **Operating and performance data for different loading rates**

Mix. FW:PS (% v/v)	HRT	OLR kg SV/ $m^3 \cdot d^{-1}$	Biogas l/h	Biogas quality % CH_4	COD removal %	m^3 biogas/m^3 biomass
0:100	15	0.66	0.139	73	64	4.55
0:100	11	0.85	0.214	73	70	5.14
5:95	18	1.0	0.309	69	68	10.79
10:90	17	1.5	0.347	69	67	12.11
15:85	16	2.0	0.490	58	77	17.11
15:85(a)	16	2.95	0.653	58	69	22.79

Conclusions

➢ The utilisation of fruit wastes as a co-substrate for digestion with pig slurry has a significant positive effect on the biogas production rate.

➢ Increasing the incorporation of fruit waste in the mixture results in a poor methane content of biogas

➢ Further research focused on the biological pre-treatment of the fruit waste is being executed in order to evaluate operating and digestion performance after pre-treatment.

Conclusions

➢ **Mobile AD pilot plant**

- 2 m^3 CSTR digester
- Operating in a pig farm
- Demonstration of the utilization of different co-substrates

➤ There are farm scale digesters available in the region.

Introduction

➤ **Very diluted pig slurry (PS)**

1,5 – 2% TS

VS/TS = 0,67

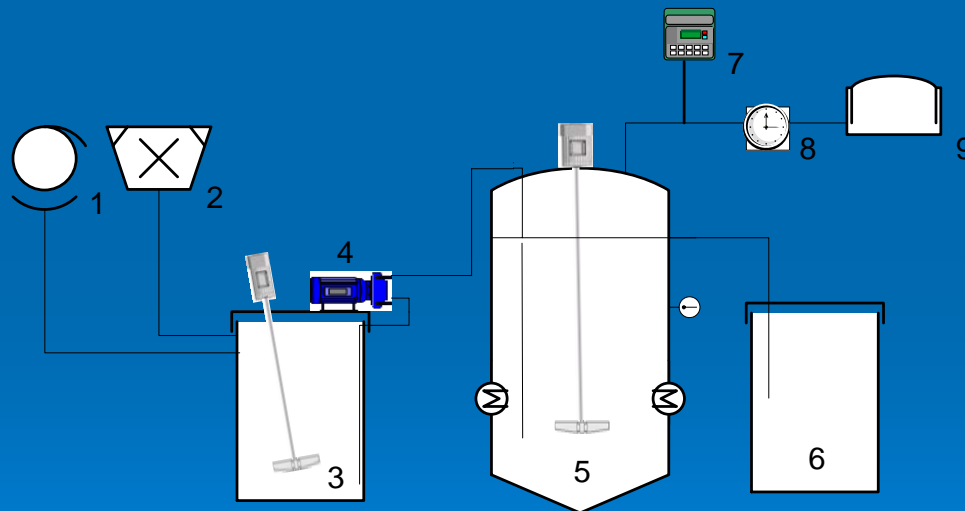**$** Great barrier to establish economical feasible AD processes

Introduction

➤ Fruit processing facility of apple and pear producers

Methods

➢ **Laboratory set up**

● Diagram of the continuos set up

1- Pig slurry screener
2 - Fruit mill
3 – Mixing / Influent tank
4 - Influent pump
5 - Digester with heating device
6 - Effluent tank
7- Gas analyser
8 - Gas meter
9 – Gas holder

Methods

> Continuos trials
  Mixtures

  FW:PS (% v/v)

	HRT d	OLR kg SV/ m3.d-1
0:100	15	0.66
0:100	10	0.85

5:95	18	1.0
10:90	17	1.5
15:85	16	2.0
15:85	16	2.95