Effect of organic loading rate on anaerobic digestion of fruit and vegetable wastes: Process performance and biogaz potential

Mouna Jraou[1], Firas Feki[1], Slim Loukil[1], Sami Sayadi[2] and Sonia KHOUFI[1]

1. Center of Biotechnology of Sfax, University of Sfax, Tunisia
2. Center for Sustainable Development, College of Arts and Sciences, Qatar

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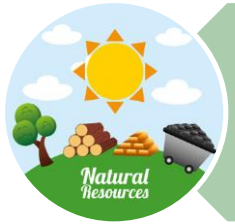
INTRODUCTION

Circular Economy

PROBLEMATIC

Population growth



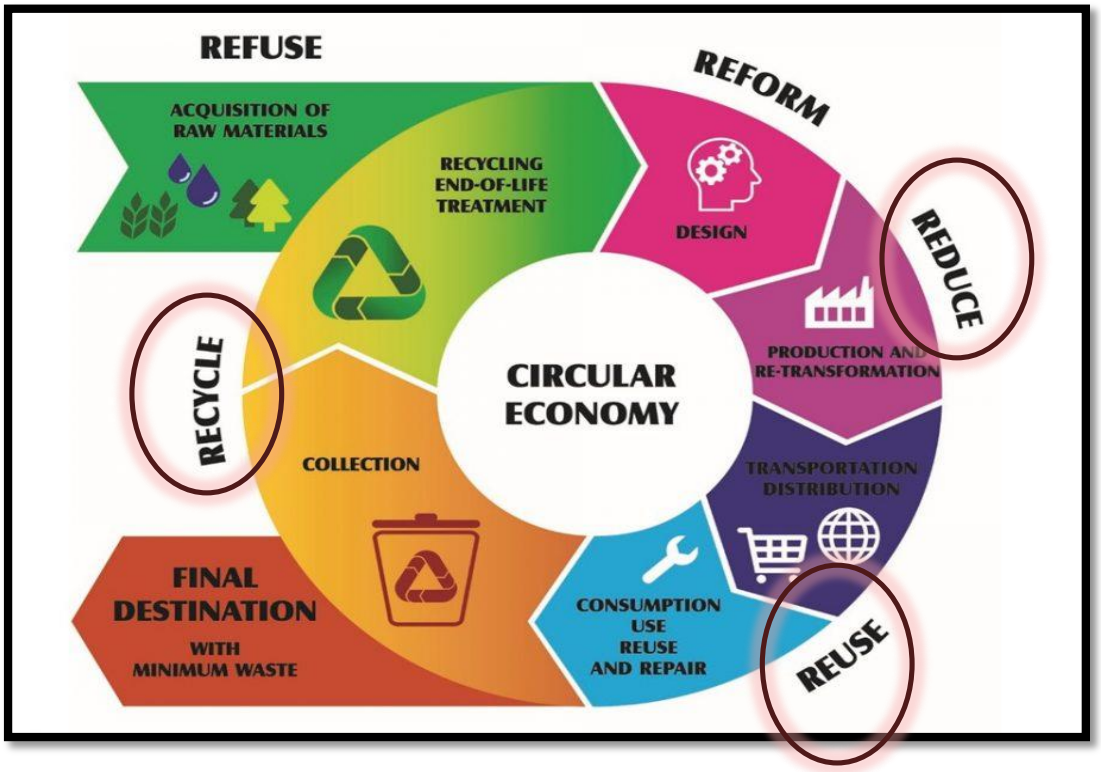
Depletion of natural resources

Environmental and economic challenges

Shifting from linear to circular models of production and consumption.

CIRCULAR ECONOMY

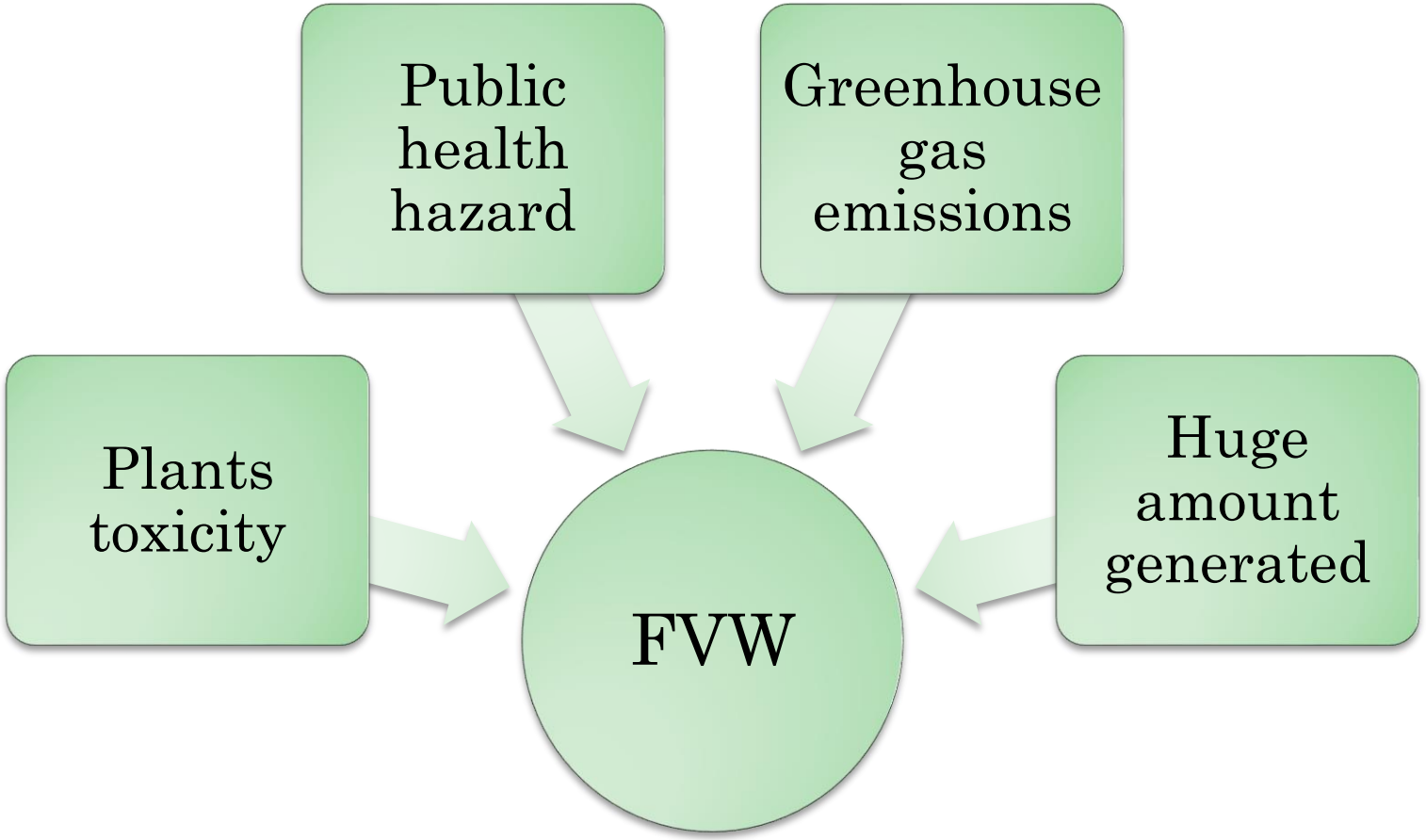
PRINCIPLES



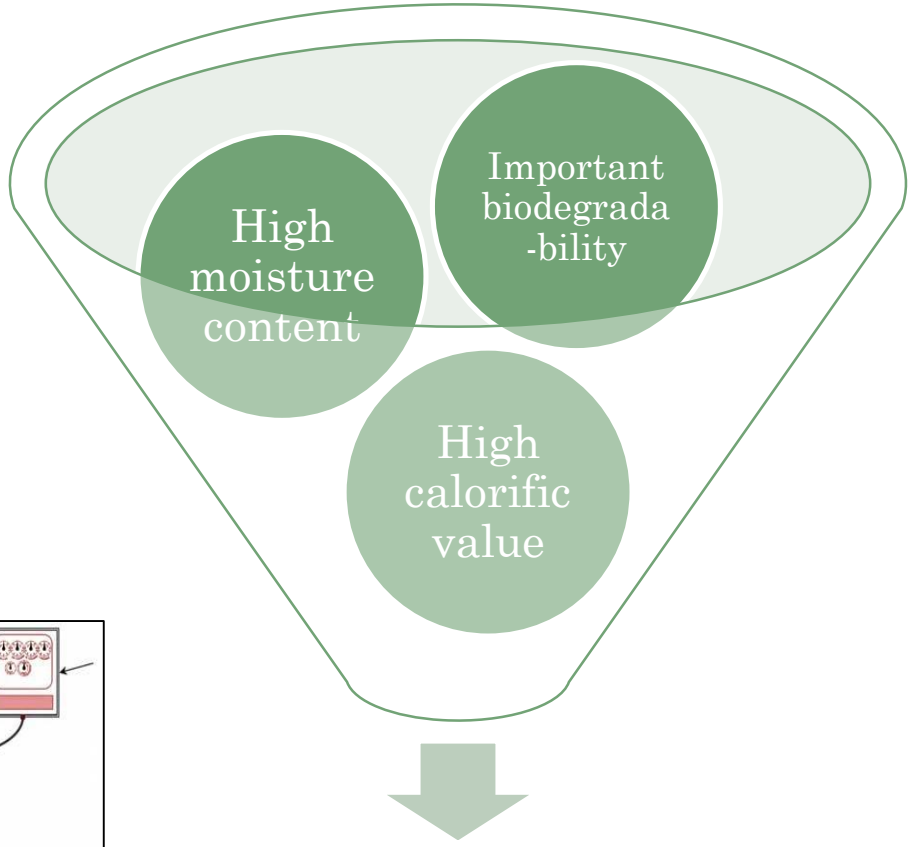
Food and vegetable waste is a key area in the circular economy and is considered as an underutilized resource that can be brought into use.

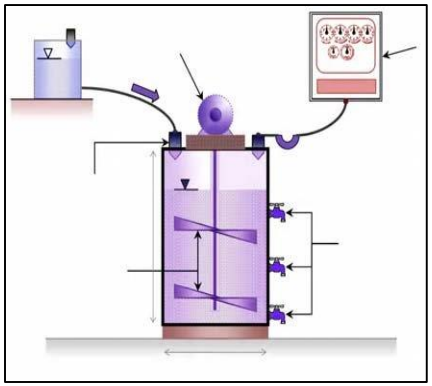
FRUIT AND VEGETABLE WASTES (FVW)

DANGERS



FRUIT AND VEGETABLE WASTES
CHARACTERISTICS

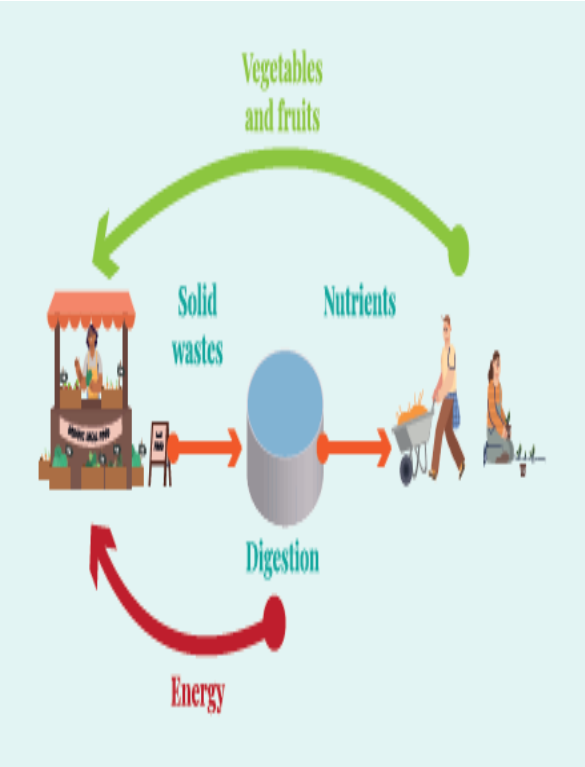




Anaerobic Digestion (AD)

Anaerobic digestion

Advantages



- Biogaz
  - Electricity
  - Heat
  - Vehicle fuel
- Digestate
  - Fertiliser
  - Bedding
  - compost

ANAEROBIC DIGESTION

LIMITATIONS

Feedstock characteristics

- Composition: carbohydrates, lipids, proteins…
- Biodegradability
- Nutrient balance

Operational Conditions

- pH
- Temperature
- Hydraulic retention time (HRT)
- **Organic Loading Rate (OLR)**

The amount of volatil solids fed into the reactor

↓

Influence directly the bioaz production

OBJECTIVES

- Characterization of fruit and vegetable wastes (FVW) generated from the wholesale market of Sfax-Tunisia.
- Evaluation of seasonal variation of methane potential of FVW.
- Assessment of the effect of increasing OLR on the performances and treatment efficiencies of a Continuous Stirred Tank Reactor (CSTR).

RESULTS

WASTE COLLECTION

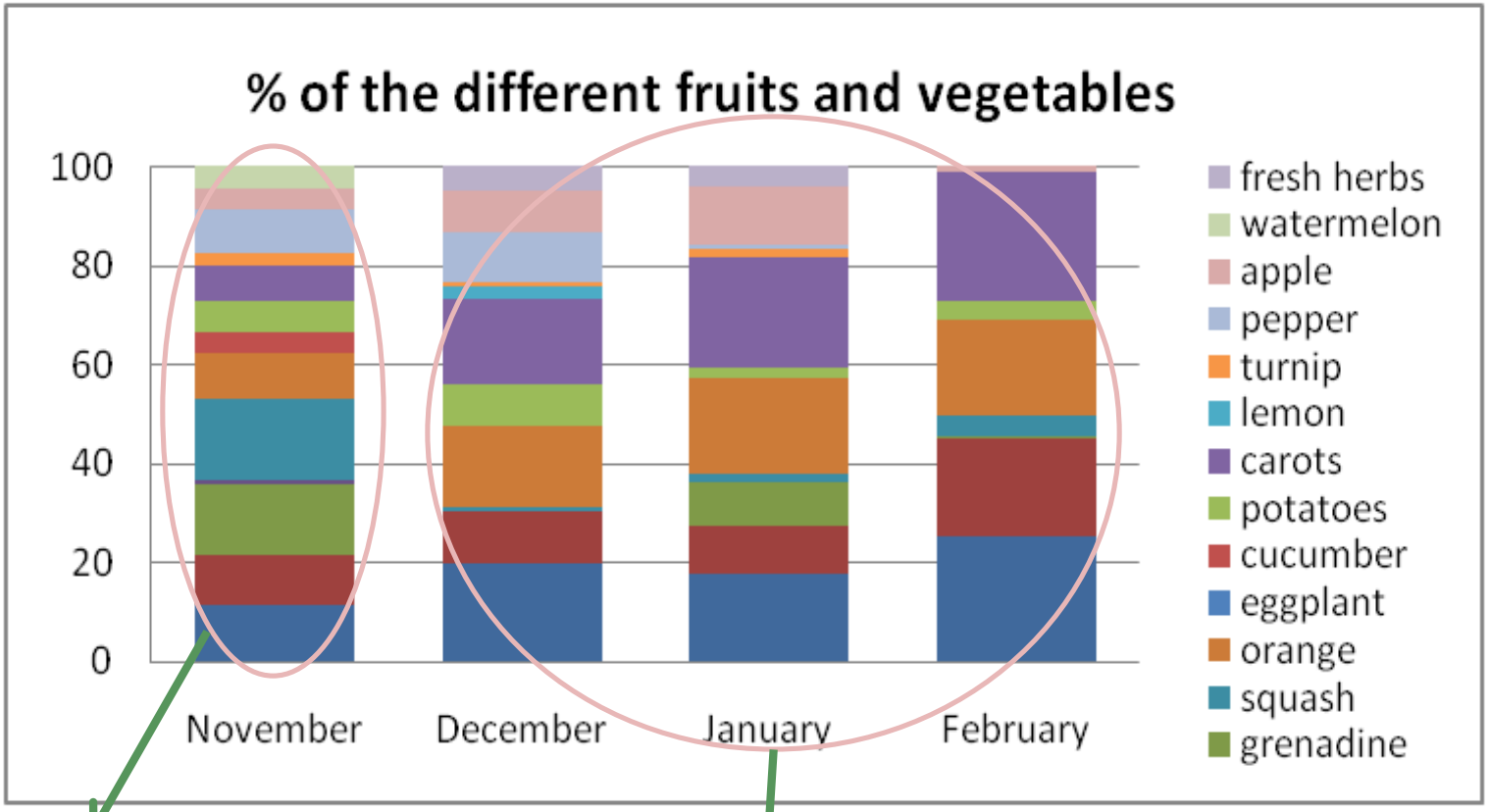
Collection

sorting

crushed

Feeding the reactor

WASTE COMPOSITION



Automn

Winter

PHYSICO-CHEMICAL CHARACTERIZATION OF FVW

Sampling month	November	December	January	February
pH	4.21	4.43	4.16	4.56
BMP (ml CH4/ gVS)	**398**	**374**	**329**	**395**
% Fruits	44.75	46.93	58.5	46.58
% Vegetables	55.25	53.07	41.5	53.42

- A balanced composition between vegetables and fruits

- Low pH : presence of fruits and vegetables that have an acidifying potential

- No significant variation of BMP between automn and winter

PHYSICO-CHEMICAL CHARACTERIZATION OF FVW

Sampling month	November	December	January	February
TS (%)	8.82	11.78	9.46	9.83
VS (%)	8.12	10.8	8.74	9.02
MM(%)	0.7	0.98	0.72	0.81
Moisture	91.18	88.22	90.54	90.17
SCOD (g/kg)	88.5	96.6	94.4	94.8
NTK (g/kg)	2.1	2.34	2.02	2.28
NH_4^+ (g/kg)	0.42	0.48	0. 39	0.46

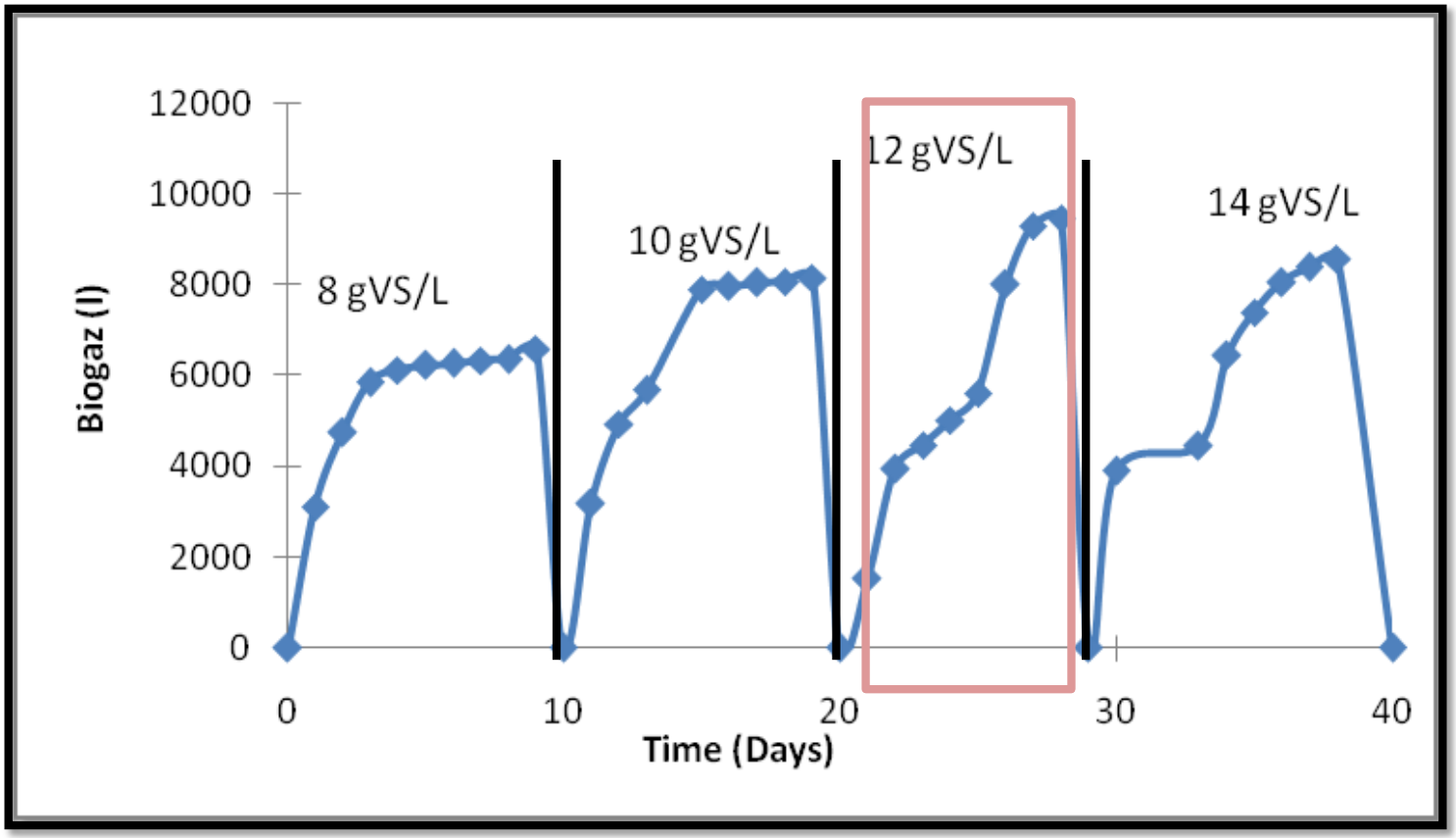
The composition of FVW is suitable to conduct wet anaerobic digestion.

Experimental setup and operational conditions

Photo of the CSTR

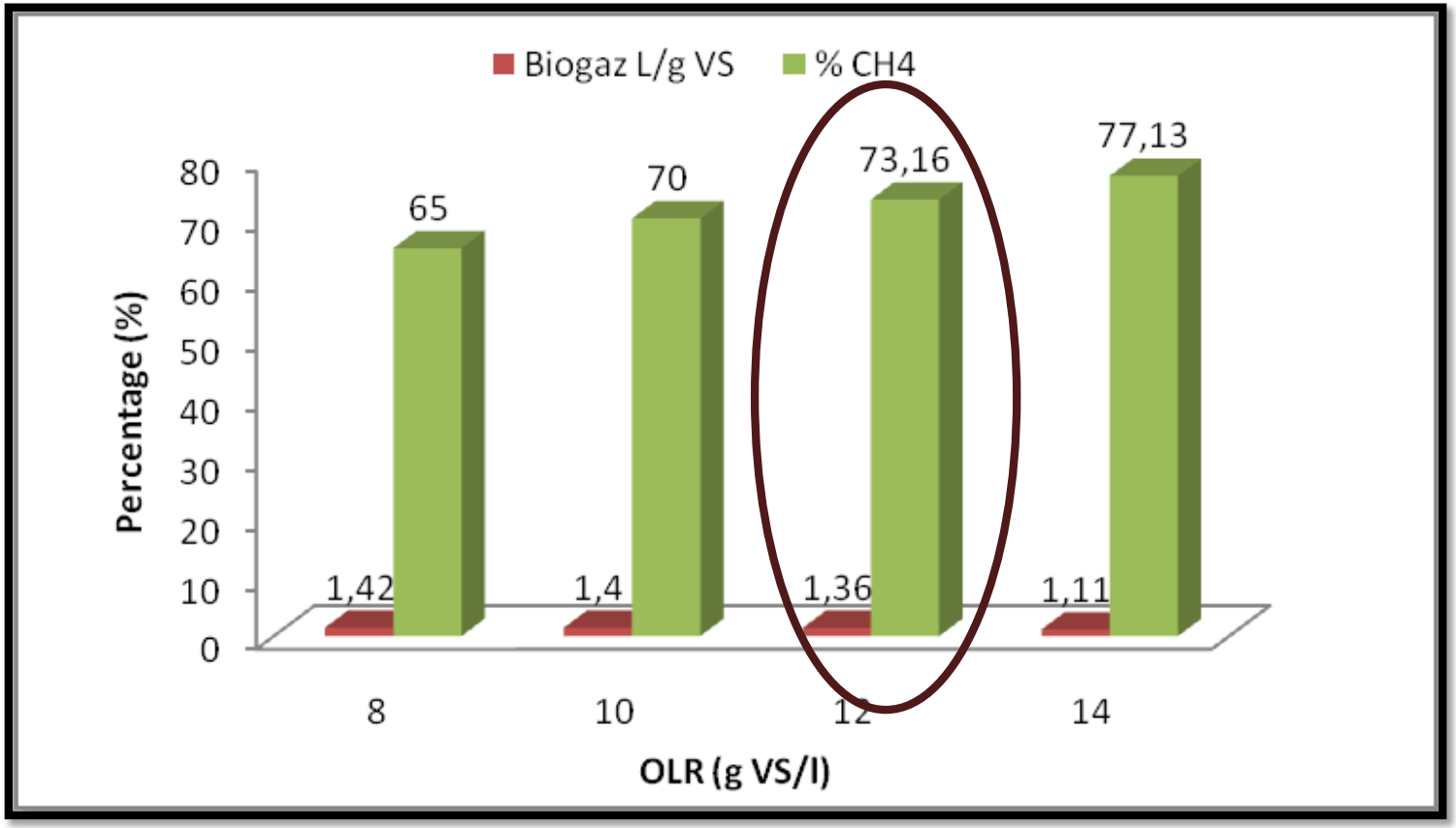
- Batch mode
- Mesophilic condition (38ºC ± 1°C).
- HRT = 10 days
- OLR ranging from 8 to 14 g MV/ L reactor

BIOGAZ AND METHANE PRODUCTION



Optimum biogas production obtained at an OLR 12 g VS / l reactor .

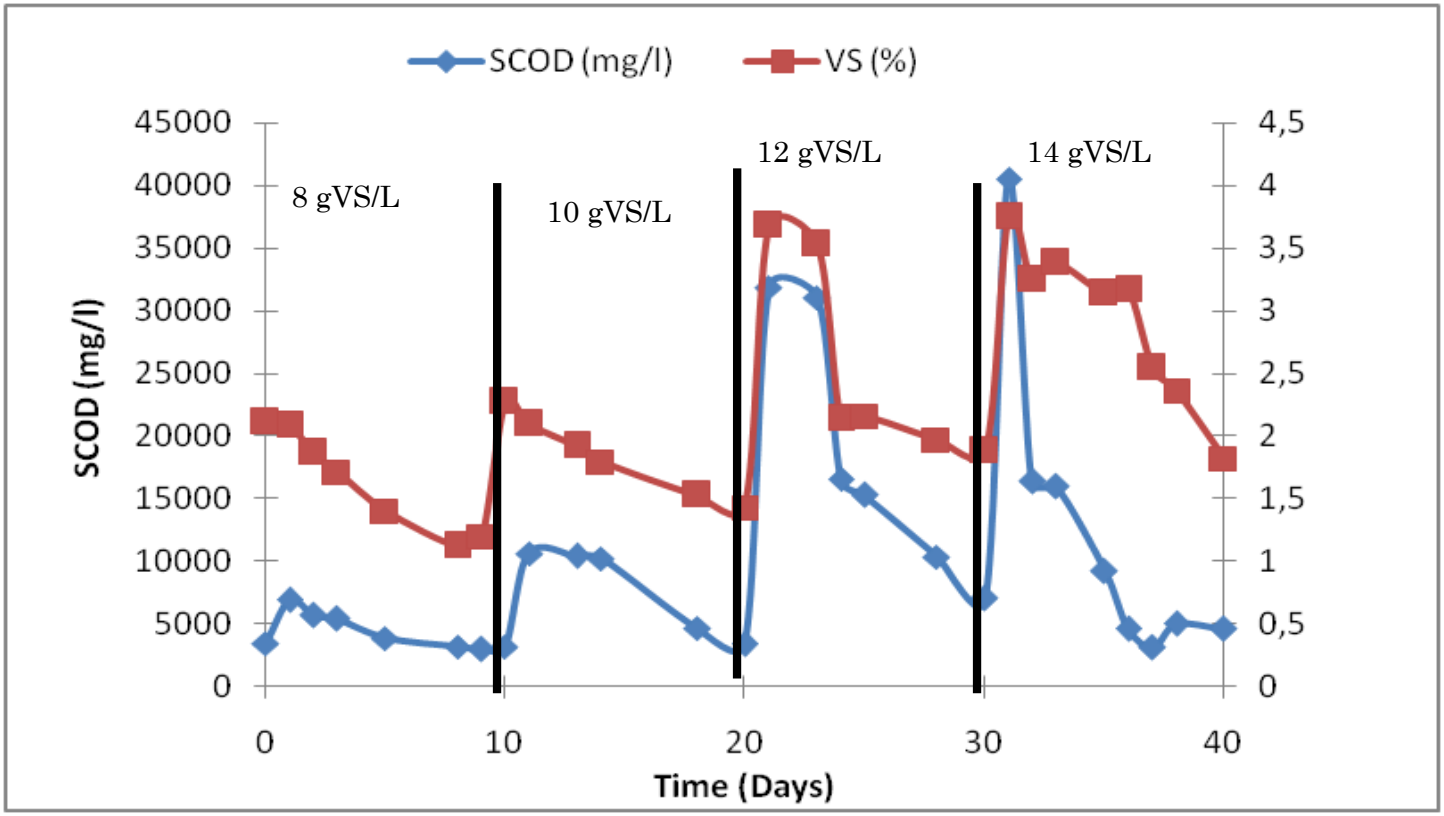
BIOGAZ YIELD



During OLR 12 g VS/ l the biogaz yield and methane percentage recorded important value.

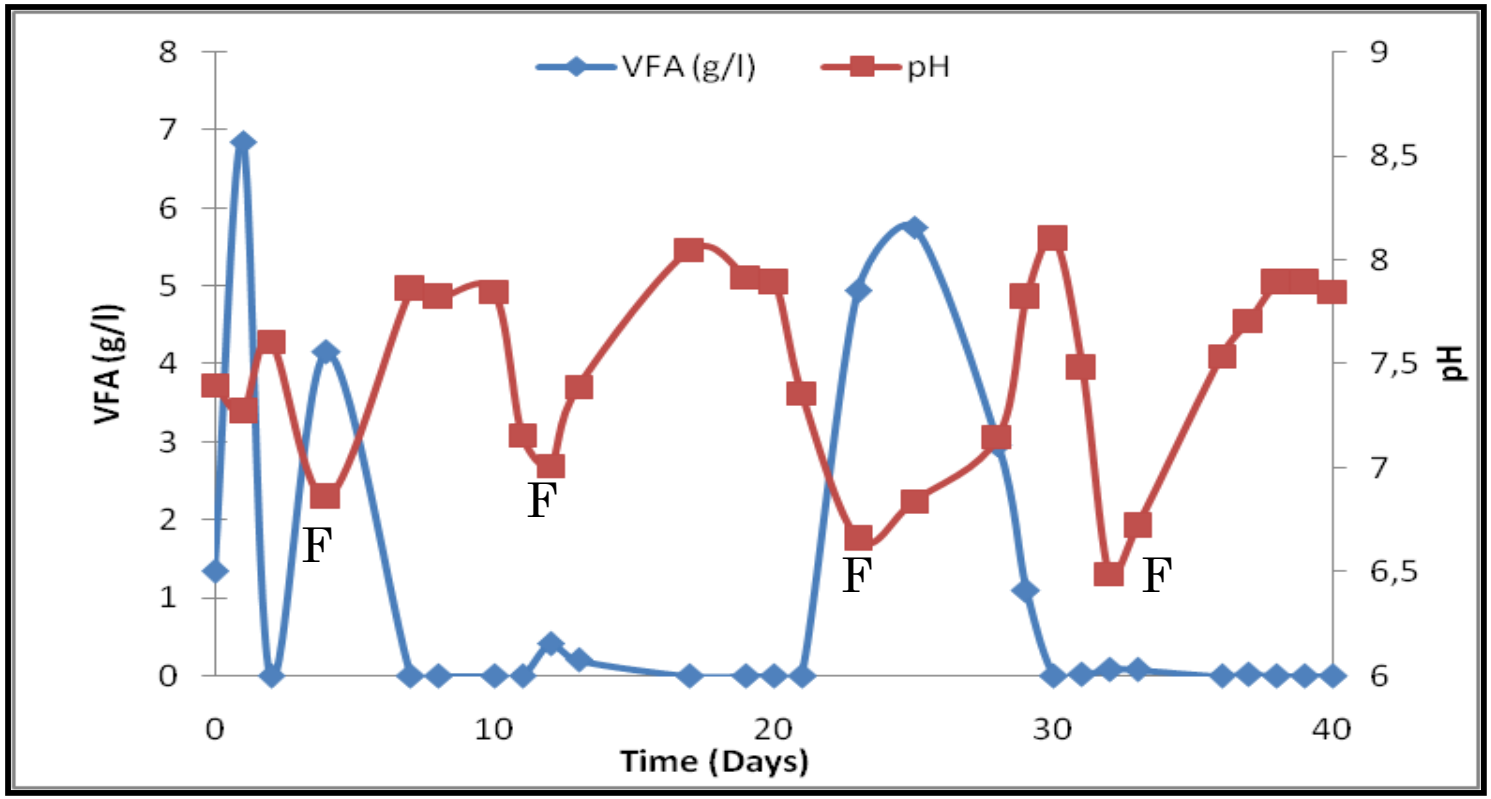
Process performances

- Organic matter and SCOD evolution



Maximum removal of SCOD (92.5 %) and VS (88%) were reached at OLR 12 g VS / l reactor

VFA EVOLUTION



F: Feeding

During fermentation the pH in the digester range between 6.49 and 8.1

Conclusions

CONCLUSIONS

- The composition of FVW generated in the wholesale market of Sfax-Tunisia is suitable for wet Anaerobic digestion .
- Anaerobic digestion is a promising process for the treatment and valorization FVW.
- The CSTR treating FVW showed a stability of anaerobic system, high biogas yield and organic matter removal of around 88% at a high loading rate of 12 g MV /l reactor.

<u>Perspectives</u>

- Studying the CSTR performance operated at a continuous mode with the integration of an hydrolysis process as a pretreatment before anaerobic digestion.

Laboratory of Environnemental Bioprocesses
Center of Biotechnology of Sfax -Tunisia

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Thank you for your attention