ENERGY RECOVERY OF WASTE FROM BIODIESEL PRODUCTION USING JATROPHA CURCAS SEEDS

Universidad de La Laguna

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Interreg

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INTRODUCTION

Production of Biodiesel from *Jatropha Curcas* involves: separating the seed from the fruit, extracting the oil from the seeds and obtaining biodiesel by transesterification of the oil with methanol, given glycerol as a by-product. Throughout this process a series of waste are obtained: discarded fruit (pulp), shell of the seeds and the cake produced in the process of extracting the oil from the seed with solvent. An added value should be given to all these waste within the idea of circular economy.

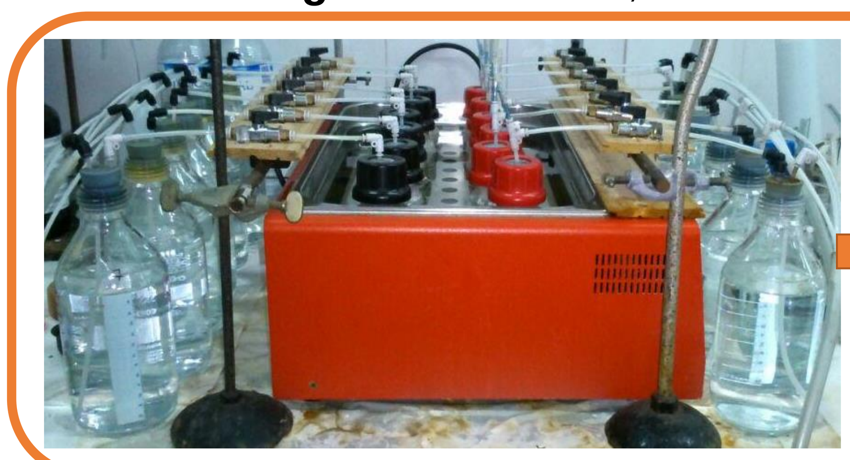
AIM

Energy recovery of the waste generated in biodiesel production using *Jatropha Curcas* seeds

- Study of the production and composition of biogas, BioDME
- Study of the direct application of waste

EXPERIMENTAL

Anaerobic Digestion: T=32ºC, without inoculum



Waste:
- 100% Pulp (P)
- 100% Cake (C)
- 60% Cake – 40% Pulp
- 60% Cake – 40% Glycerine(G)
- 60% Cake – 40% Shell (S)

- **Influence of the type of waste in:**
  - Gas production
  - Gas composition
  - Total and volatile solids of the waste before and after digestion

Thermogravimetric analysis

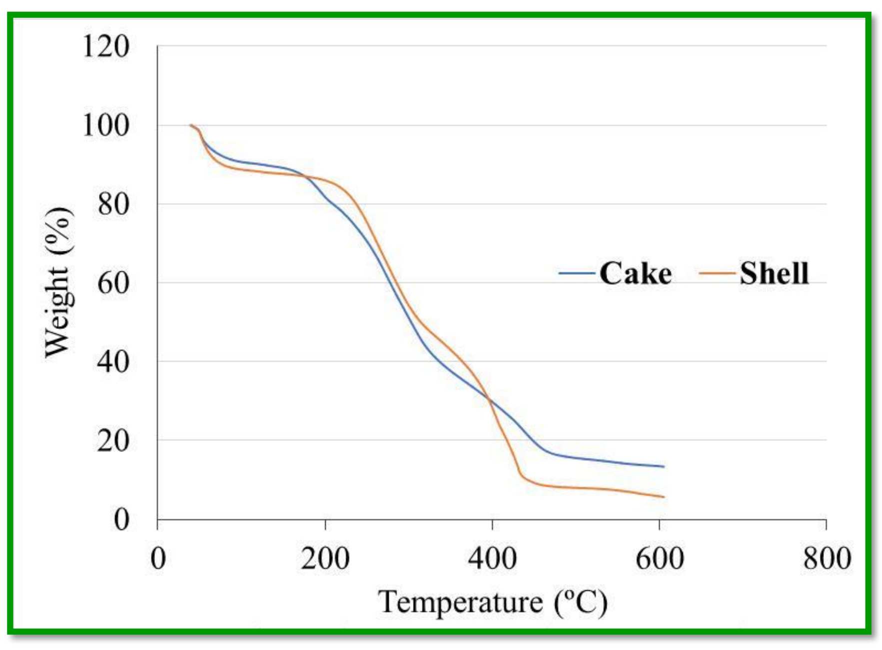
- **Direct energy recovery:**
  - Cake
  - Shell

DIRECT ENERGY RECOVERY

The higher heeting value of the wastes with higer solid content (C,S) will gives an indication of their energy recovery capacity.

Correlations of higher heating value with the waste composition	
Álvarez A. et al., 2012	PCS = 18.0124 – 0.0041·L [1]
	PCS = 16.5917 + 0.0191·H [2]
	PCS = 16.9961 + 0.0198·C [3]
	PCS = 15.9391 + 0.0210·L + 0.0250·C [4]
	PCS = 14.2252 + 0.0424·L + 0.0295·H [5]
	PCS = 14.2193 + 0.0425·L + 0.0305·H – 0.0015·C [6]
Shafizadeh F., 1976	PCS=0.17389·H+0.26629·L+ 0.32187·E
Tillman D.A., 1978	PCS = 0.19389H+ 0.26629·(100-H*)
Jiménez L., 1991	PCS=(1-[Cenizas]/(H+L+E))·(0.17389·H+ 0.26629·L+ 0,.32187·E)
Demirba A., 2003	PCS** = 0.0889·L** + 16.8218 [1]
	PCS = 0.0893·L** + 16.9742 [2]
	PCS = 0.0877·L** + 16.4951 [3]
	PCS** = 0.0864·L** + 16.6922 [4]

Dry base extractable weight; L, dry base lignin weight; H, dry base holocellulose weight; C, dry base cellulose weight; * dry base weight composition free of extractable; ** dry base weight composition free of ash and extractable.



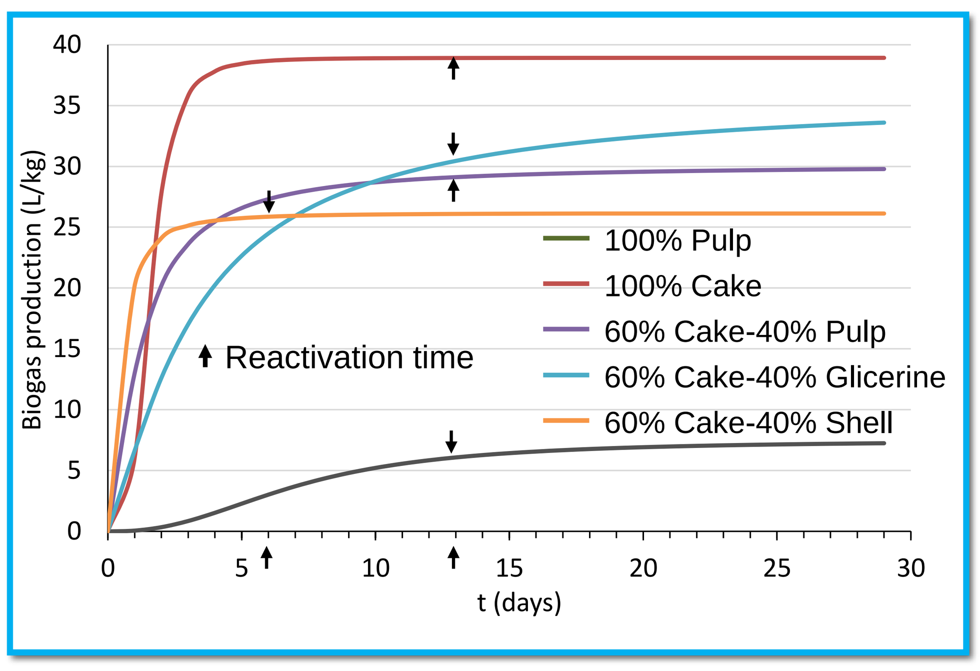
Thermogravimetric analysis

- The average values obtained are 17.75 kJ/g for the cake and 18 kJ/g for the shell, with a difference respect to the wood in the range of 2.2% to 4.0%.

Higher heating value for the different correlations. PCS, kJ/g			
Correlation		Cake	Shell
Álvarez A. *et. al.*, 2012	[1]	17.99	18.00
	[2]	17.75	18.04
	[3]	17.48	17.78
	[4]	16.66	17.00
	[5]	16.23	16.61
	[6]	16.25	16.62
Shafizadeh F., 1976		19.04	18.93
Tillman D.A., 1978		17.64	17.55
Jiménez E.F., 1991		16.43	17.78
Demirba A., 2003	[1]	17.51	17.19
	[2]	17.67	17.35
	[3]	17.18	16.86
	[4]	17.36	17.05

BIOGAS

Biogas Production

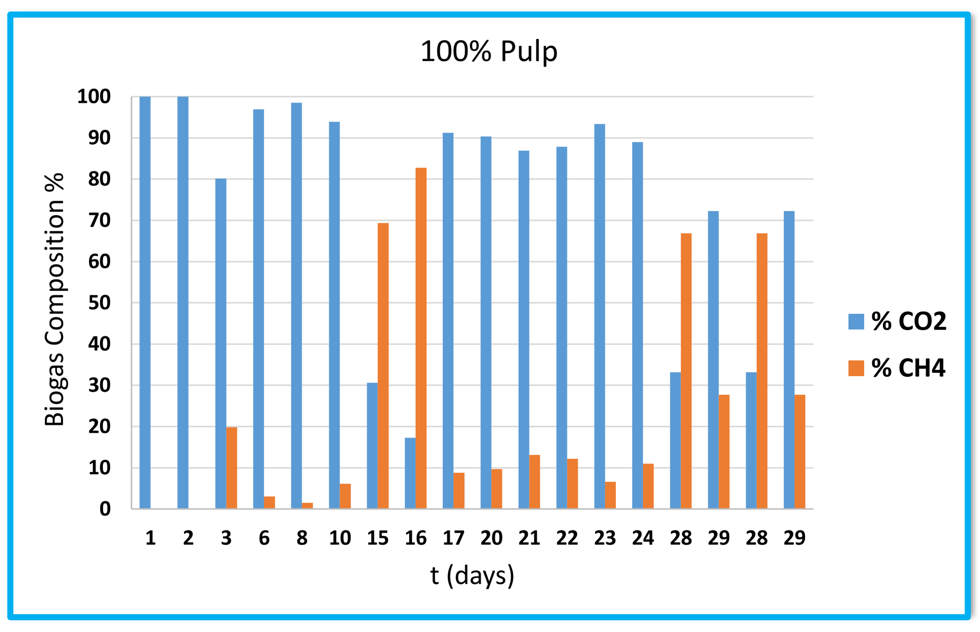


- Except for the cake-shell mix, maximum gas production occurs in the first 3 days.
- Production stops after ≈ 13 days and it has been verified that a pH decrease had occurred.

- The system was reactivated by restoring the pH and only a slight increase in production was observed.

pH variation			
Waste	Initial pH	pH before reactivation	pH after reactivation
P	8.38	5.78	8.23
C	7.60	6.68	7.28
CP	7.71	6.28	8.12
CG	7.87	5.54	8.16
C-S	7.64	6.11	8.10

Biogas Composition



- In general before reactivation the gas is only CO_2.
- After reactivation CH_4 is produce but below a 50% concentration.

- Only the pulp gives rise to biogas with 60% methane, the rest of the wastes produce practically only CO_2 which makes them suitable to obtain BioDME by catalytic hydrogenation processes.

DIGESTATE CHARACTERIZATION

Digestate characteristics				
Waste	Initial		After Digestion	
	Total Solid (TS),%	Volatile Solid (VS),%	Total Solid (TS),%	Volatile Solid (VS),%
P	11.0	76.5	11.5	86.5
C	88.5	68.0	15.0	66.0
CP	57.0	71.5	11.5	68.0
CG	73.5	72.0	16.0	75.0
CS	88.0	68.5	18.5	75.0

- The concentration of volatile solid in the digestate resultant from the process indicates that they still have solid to be digested, what it suggests that the process stops for an excessive descent of the pH.

CONCLUSIONS

- The pulp, cake and glycerol generated in the biodiesel production process can be converted in Biogas and BioDME, while the shell and cake can also be used directly for their higher heating values.
- The mixtures could be digested with inoculum to stimulate the presence of methane and direct all production towards Biogas.

References:
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