An integral and sustainable approach of *Jatropha curcas*: Towards a circular economy

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1. Introduction – Nowadays economic activity is based on a linear model where raw materials are extracted, processed into finished products and become waste after they have been consumed, unlike the circular economy works according to the 3R approach of "Reduce, Reuse and Recycle". It bases on the establishment of closed production systems, where resources are reused and kept in a loop of production and usage, allowing generating more value and for a longer period [1]. The European Environment Agency (EEA), in its study "Circular economy in Europe" identified the benefits that advancing a circular economy could offer to EU countries. A fragmented territory such as the Canary Islands, tend to have common problems related to fuel dependence, electricity production costs, waste treatment, and a declining agronomy sector. In this sense, this work proposes the integral use of the *Jatropha Curcas*, non-edible plant, as an agronomic source of energy for the Canary Islands, to help achieve energy self-sufficiency and improve waste management to reactivate the agronomy sector within the framework of a circular economy.

2. Experimental - In this study, the capacity of a *Jatropha Curcas* crop for the production of biofuels within a circular economy is evaluated. The methodology was carried out in two stages. The first corresponds to the optimization of the biodiesel production process using the oil extracted from its seeds reacting with methanol in the presence of a catalyst, and the second stage was the use of all the waste generated during that process: Jatropha pulp, seed shell, cake from the oil extraction process and glycerol from the biodiesel production. The use Jatropha seed shells and extraction cake as solid pellet was evaluated by measuring its calorific value, and their capacity to be transformed into bioethanol and Green Diesel by means of the holocellulose content. The anaerobic digestion of all the waste, alone or mixed, gives rise to a gas that depending on its composition can be used as biogas or to obtain MeOH/BIODME.

3. Results and Discussion - Parameters for oil extraction and biodiesel production, were optimized obtaining a yield of 0.67 t/ha of low acidity oil suitable to obtain biodiesel, and the production of biodiesel was 0.52 t/ha. Regarding the use of the waste generated during the process, all of them alone and mixed, presented a high gas production by anaerobic digestion, mainly composed of CO_2 that could be used for the production of BioMeOH/ BioDME. The calorific value of both the cake and the *Jatropha* shell show values similar to that of wood (18.5-19.0 kJ/g), therefore these wastes can be used as fuels in the form of solid pellets. They also presented holocellulose content higher than 50%, which is of great interest, the glycerol by-product, when mixed with other residues, increases ≈ 20% the production of gas by anaerobic biodigestion and purified can be used for the production of soaps and creams.

Table I. Energetic recovery

Waste	Solid Pellets PCS (kJ/g)	Holocellulose (%)	Gas Production (NL/kg)
Cake	17.75	55	39.0
Shell	18.08	65	(+ 60% cake) 26
Pulp	---	---	7.6
Glycerol	---	---	(+ 60% cake) 35.6

4. Conclusions - The cultivation of *Jatropha Curcas* for the production of biodiesel and the used of the waste generated can enter into the circular economy, producing three green energy sources such as biomass for direct combustion and liquid and gaseous biofuels.

5. References

[1] Urbinati, A.; Chiaroni, D.; Chiesa, V. Towards a new taxonomy of circular economy business models, Journal of Cleaner Production 168 (2017) 487- 498.

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