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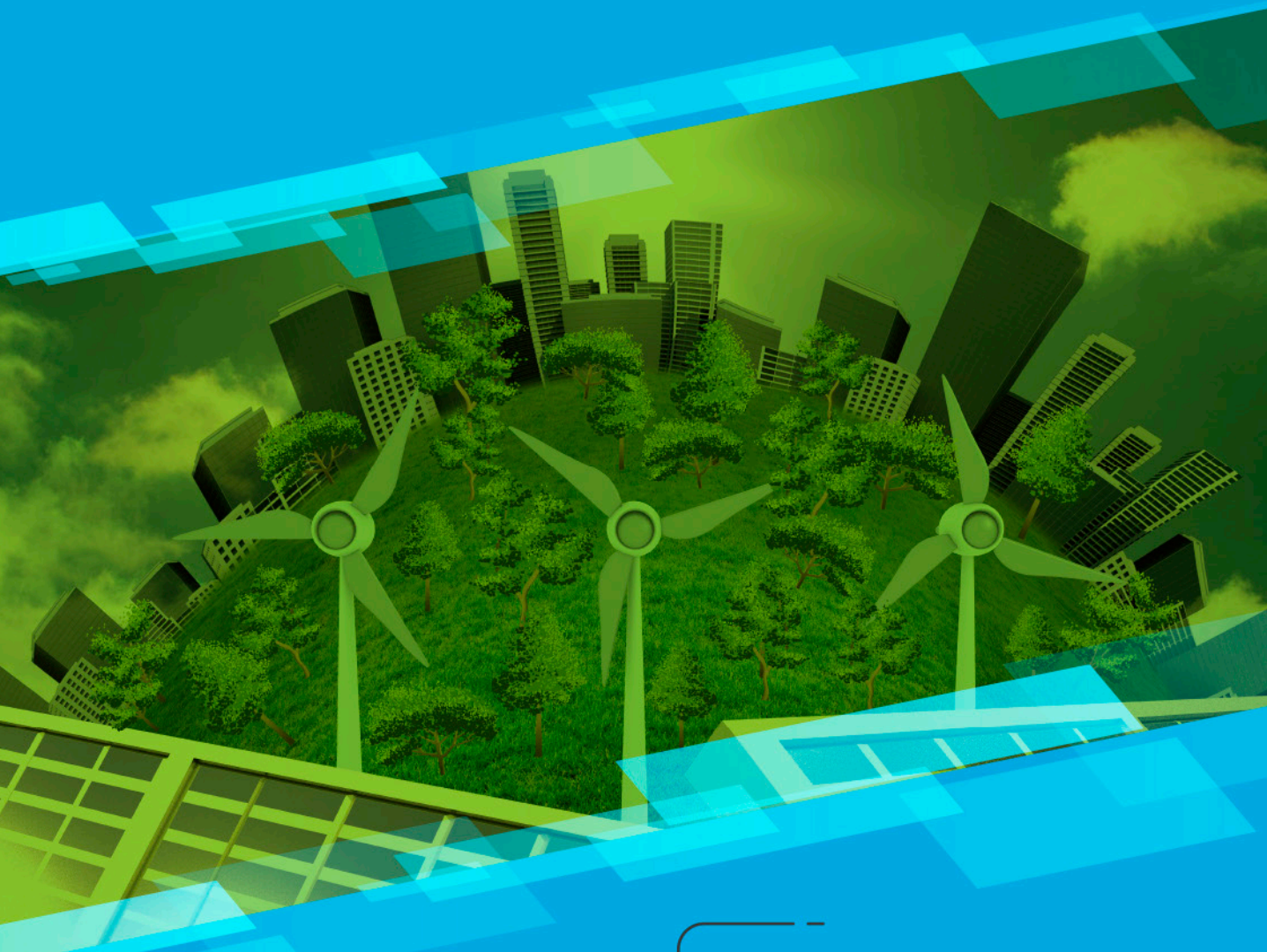

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Time to the coffee break: Can coffee waste materials be used in a circular economy?

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Introduction

The bioeconomy and the circular economy concepts are becoming increasingly important in the agricultural and industrial sectors. There is an increasing interest in obtaining traditional petrochemical based products from bio-based feedstocks and processes in order to attain a sustainable economy. The present research reports the use of biomass waste materials from coffee manufacturing in small biorefinery options.

Problem

Lignocellulosic biomass waste has a complex structure consisting of three major fractions: cellulose, hemicelluloses and lignin; and their relative abundances depend on the type of biomass feedstock (Huang et al., 2008). Depending on the quantity of all these major fractions and the individual compounds, the valorisation opportunities can vary. Therefore, the importance of the use of traditional and new characterisation methods of these kind of materials becomes relevant. In addition to the economy and feedstocks, social impact in some areas need to be considered in future biorefineries. In this sense, a domestic bio-based economy needs to be studied in these areas to foster innovation and to spur the modernisation of the agricultural sector.

Coffee processing is a good example with a production of 31.8 million € in exports and it is the fourth agricultural product marketed (Zarrinbakhsh et al., 2014). More than 2,300 million cups of coffee are consumed in the world every day and most of the coffee consumption takes place in industrialised countries, while 90% of coffee is produced in developing countries (Hughes et al., 2014), especially in rural and vulnerable areas.

Objective

Study the possibilities offered by waste coffee processing materials in small biorefinery options under a circular economy concept. This work is based on the identification of the waste materials in different areas, the identification of the best characterisation methods and the use of the chosen characterisation methods (traditional and novel) in two coffee waste materials. In addition, some possibilities of valorisation options can be given.

Methodology

Used coffee grounds and silverskin are characterised, being about 50% of the waste from the coffee processing (Janissen & Huynh, 2018). The analysis of ash, water content, extractives (ISO 14453:1997), cellulose, hemicellulose and lignin by Van Soes methods (Viel et al., 2018) and the analysis of individual sugar and other decomposition compounds by acid hydrolysis and HPLC (Llano et al., 2017) are studied.

Results

Coffee manufacturing is a complex process not only within developing countries but also in more industrialised ones. Depending on the stage, different waste materials can be used for valorisation options, from skin, pulp, mucilage, hull and silverskin from the coffee cherry to the used coffee ground. In this work, an identification of all of the waste materials in coffee processing under a circular economy perspective together with the possibilities in developed and more industrialised countries have been carried out. A general scheme has been proposed including all the processing steps. The second step was to study the characterisation methods to separate the different fractions for valorisation opportunities. In this case, two waste materials (silverskin and used coffee grounds) have been characterised. The results give more possibilities for cellulose-based products (paper, fibres, textiles or biofuels) and lignin (energy valorisation and additives). In addition, and in order to study the valorisation options from a sugar platform, a new methodology of hydrolysis and HPLC characterisation has been used to obtain the individual compounds in both residues. Glucose, galactose, arabinose and mannose are the main sugar compounds in both waste materials. However, in the case of silverskin, xylose is another possibility to be valorised into xylitol or biopolymers. The concentration of other decomposition compounds (acids and furans) is negligible in both residues.

Conclusion

Waste materials from coffee processing fulfil the requirements to be valorised using small biorefineries in rural and industrialised areas. Silverskin and used coffee grounds can be valorised into fuels and energy, cellulose-based products, and products from sugar fermentation. This work will be the basis of future studies in different areas (including vulnerable areas in Colombia) in order to use the obtained products as every-day products and energy. Main pre-treatments for separating the main fractions and future studies in which these options will be techno-economically evaluated by simulating the entire processes, using Aspen Plus® software, will be carried out.

References

Huang, H.-J., Ramaswamy, Sh., Tschirner, U.W. & Ramarao, B.V. (2008). A review of separation technologies in current and future biorefineries. *Separation and Purification Technology*, 62(1), 1-21. https://doi.org/10.1016/j.seppur.2007.12.011

Hughes, S., López-Núñez, J., Jones, M., Moser, B., Cox, E., et al. (2014). Sustainable conversion of coffee and other crop wastes to biofuels and bioproducts using coupled biochemical and thermochemical processes in a multi-stage biorefinery concept. *Applied Microbiology and Biotechnology*, 98(20), pp.8413-8431. https://doi.org/10.1007/s00253-014-5991-1

Janissen, B. & Huynh, T. (2018). Chemical composition and value-adding applications of coffee industry by-products: A review. *Resources, Conservation and Recycling*, 128, 110-117. https://doi.org/10.1016/j.resconrec.2017.10.001

Llano, T., Quijorna, N., Andrés, A. & Coz, A. (2017). Sugar, acid and furfural quantification in a sulphite pulp mill: Feedstock, product and hydrolysate analysis by HPLC/RID. *Biotechnology Reports*, 15, 75-83. https://doi.org/10.1016/j.btre.2017.06.006

Viel, M., Collet, F. & Lanos, C. (2018). Chemical and multi-physical characterization of agro-resources' by-product as a possible raw building material. *Industrial Crops and Products*, 120, 214-237. https://doi.org/10.1016/j.indcrop.2018.04.025

Zarrinbakhsh, N., Wang, T., Rodriguez-Uribe, A., Misra, M., Mohanty, A. (2016). Characterization of wastes and coproducts from the coffee industry for composite material production. *BioResources*, 11(3), 7637-7653.