

Design of a prototype antioxidant isolation unit from espresso coffee beverage production waste

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ABSTRACT

The objective of this study was the optimization of the recovery process for the isolation of phenolic compounds from coffee spent grounds and the use of optimal parameters for the techno-economic pilot plant design. Through the extraction experiments the optimal conditions were investigated, specifically the solvent to solid ratio (5-50 mL/g waste), the ethanol concentration in the aqueous mixture (0-100%), the extraction time (5-360 min) and the use of ultrasound. Additional experiments dealt with the effect of consecutive extractions on the final gained amount of phenolic substances, as well as with the imposition of the final optimal sample in rotary evaporation. The parametric study showed that the optimum process parameter values were: 10 mL/g solvent to solid waste ratio, 20% H₂O/80% EtOH solvents' ratio, extraction time equal to 60 minutes, ultrasound as extraction method and an optimum number of consecutive extractions equal to one. The final percentage of purity of phenolic compounds obtained was 60%. Under the above conditions, a technical and economic study and a pilot unit design took place. Initially, the process flow diagram was constructed, and the technical characteristics and dimensions were analyzed. Then, the cost of the equipment was estimated in order to examine the financial viability of the pilot unit. The unit capacity was set at 12 t/y and the indicative selling price was defined at 13\$/g. Based on the total annual income and production costs, the tax disbursements, the loan interest and depreciation we concluded that, through a 6-year long investment plan, the proposal is profitable.

Keywords: Spent coffee grounds, Phenolic compounds, Solvent extraction, Pilot unit, Techno-economic study

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