Valorizing Agro-Industry Residues to Improve the Environmental Sustainability of Frozen Products

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***Abstract.*** Although processing fruits and vegetables into shelf-stable products reduces losses, proving to be a viable solution, significant losses still occur at various stages. The European Green Deal proposes a circular economy concept based on the perception of environmental and economic benefits, which has led to a push that calls for valorizing agro-industrial residue. Considering the paradigm shift towards renewable energy due to the high ecological impacts associated with fossil fuels, generating biogas energy from agricultural residue for electricity is a smart use. The present study is related to a large Italian agriculture consortium that produces and transforms vegetables mainly intended for the frozen market and operates within Italy's central and southern parts. The main processed product is the pea, distributed to important Italian frozen products brands such as Findus and Orogel. The production takes place in 3 months (April, May, and June). In this period, the agro-industrial pea residues constitute the only fresh plant matrix fed into the consortium's biogas plant. The manufacturer, for peas processing, reports an annual average material loss between 15-30%, corresponding to 1.12E+03 tons. The waste generated goes to a biogas powerplant for conversion to electrical energy with digestate as a co-product. The biogas is produced from co-fermentation feeding with 50-55 tons per day, using a mix of corn silage (44-58%), pea residues (27-40%), and chicken manure (15-16%) as feed during the reference period. Specifically, this study investigates the environmental benefits of using agro-industrial residues as partial replacement of the typical energy biomass (corn silage) and from the partial substitution of fertilizer with digestate, which is returned to farmers in a circular nutrient cycle. As part of the study, the ecological sustainability of the biogas power plant will also be evaluated, along with potential areas for improvement in the production chain. Following the ISO 14040/14044 standards, a life cycle assessment will be conducted. Primary data has been collected from the manufacturer using a well-structured questionnaire and official documents for 2019 and 2020. The CML-IA baseline method will be applied to assess various environmental impacts such as global warming potential, eutrophication potential, and acidification potential. The results from the study are expected to promote the trend towards using renewable energy sources through local circular economy systems.