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Hybrid tunnel solar dryer for coffee processing in Colombia: Design and experimental evaluation

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Abstract

Open-sun and solar drying of coffee are used worldwide to lower the moisture content of the beans. Their easy setups and low running costs attract coffee growers; however, these processes are difficult to control and predict due to their dependence on climate conditions. Due to the extended drying time these procedures undergo, the development of microorganisms, mycotoxins and moulds threaten the product. Alternatives such as mechanical dryers are available, allowing to dry large amounts of coffee in shorter times; nevertheless, their running costs and setup are usually expensive and unaffordable for small-scale coffee growers. Therefore, this research aimed to design, build and evaluate a hybrid solar tunnel dryer which mixes solar and mechanical drying principles. It uses a traditional solar tunnel-type dryer as a base featuring a biomass burner which uses coffee trunks left from the yearly crop renovation as biofuel. A heat exchanger heats the drying air, afterwards blown into a plenum chamber that homogenizes the air's static pressure before crossing the coffee bed, ensuring an even moisture removal. Also, the hybrid unit includes a photovoltaic system to obtain a fully self-sufficient drying unit. The newly developed dryer was tested under three different configurations: Solar and mechanical day and night (C1), solar during the day and mechanical during the night (C2) and fully solar with non-mechanical aid (C3). The results displayed a notable drying time reduction in the three evaluated configurations, low biomass consumption and improved temperature and relative humidity profiles. Its design easily adapts to the existing tunnel and parabolic-type solar dryers.

Keywords: Biomass, coffee, coffee drying, hybrid dryer, tunnel dryer

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