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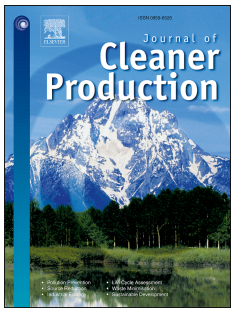

Energy analysis of hybrid solar tunnel dryer with PV system and solar collector for drying mint (MenthaViridis)

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Energy analysis of hybrid solar tunnel dryer with PV system and solar collector for drying mint (MenthaViridis)

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Abstract: This work aims to develop a hybrid portable solar tunnel dryer and enhance its performance using solar photovoltaic system and flat plate solar collector for drying peppermint. The solar tunnel dryer can work in mixed mode (direct and indirect thermal heating). The photovoltaic system is used to operate an axial direct current fan (forced mode). Also, the solar tunnel dryer is provided with a thermal curtain to shade mint and protect it from direct solar radiation. The solar tunnel dryer performance is evaluated by using single, double and three layers of mint, and compared with open sun drying. Predicted and experimental moisture ratio of mint leaves using developed solar tunnel dryer were compared through several models of thin-layer drying. The effect of embodied energy of the developed hybrid solar tunnel dryer on environment was studied. Results indicated that the drying time of peppermint was varied from 210 to 360 min for the developed dryer, while varied from 270 to 420 min for open sun drying. It has been noticed that peppermint drying happened in falling-rate period. The two-term model was the best model to simulate the solar thin layer drying process of peppermint for all treatments. The daily average photovoltaic efficiency was 9.38%, dryer efficiency was 30.71%, overall efficiency was 16.32%, energy payback time was 2.06 years and net carbon dioxide (CO_2) mitigation over the lifetime was 31.80 tons. The quality of the dried peppermint by using black thermal curtain in the solar tunnel dryer is higher than that dried in the open sun as the natural color and the appearance are retained more under shading. This system is quite useful for people living in remote areas, where grid connectivity is not available and it can meet the demand of farmers.

Key words: Mixed mode solar tunnel dryer, drying efficiency, modeling, photovoltaic system, solar air collector, diffusivity coefficient, embodied energy, CO_2 emission, peppermint, color analysis

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