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Performance evaluation of a solar rack dryer equipped with a supplementary heat storage

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A solar rack dryer was constructed and tested with a single flat plate collector together with granite chips and granite rubble as sensible heat storage materials and paraffin wax as a latent heat storage material. The collector was made using black corrugated galvanized sheets as absorbance bed, with a clear glass top. The size of the collector was 1.8 m x 0.7 m and the inclination was 7^o facing South. The dryer was modified by extending the collector area to have an extra area of 1.3 m^2 with 10 cm thick layer of granite chips and a 25 cm thick layer of granite rubble. It was further modified by incorporating 5 aluminum trays and 4 PVC pipes of length 1 m, each filled with 30 kg of paraffin wax to the bed of the granite rubble. Drying trials were conducted to test the performance of the prototype and modified system using 3 mm thick pineapple slices. The temperature development of the flat plate collector was below the required level for perishable dehydration (50–60 ^{o}C) under a natural draft in the range of 0.1-0.12 m/s. The results showed that the dryer was unable to reduce the moisture content of the slices below 20% in five days, indicating poor quality. Laying of heat storage materials of granite chips and granite rubble increased the collector area and gave encouraging results. The temperature built up in the drying chamber with the collector composed of flat plate, granite rubble and chips and granite rubble with paraffin wax were in the range of 50-55 ^{o}C after 1.30 p.m. and remained stable till afternoon. The air flow was doubled owing to supply of more heat energy. The moisture content of the products that were kept at ambient temperature and that were kept inside the dryer, were measured each day at the beginning of drying and in the afternoon continuously for four days. The moisture content of the final product that was kept inside the dryer showed no change. This indicated that no moisture re-sorption had occurred during the night when the product was inside. The results showed that a system that combines all heat storage materials with different thermal properties enhanced heat storage more than a single material used separately in the solar rack dryer. Further, the availability of more energy makes it possible to increase the air flow rate using forced air. There may be a relative amount of heat loss through the collector during nights, the proportion which was not counted in this study.

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