	INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI **SHORT ABSTRACT OF THESIS**

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Programme of Study	:	Ph.D.
Thesis Title: **Development and Performance Investigation of a Solar Dryer Integrated with Latent Heat Storage**		
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Thesis Submitted to the Department/ Center	:	Yes
Date of completion of Thesis Viva-Voce Exam	:	4.07.2017
Key words for description of Thesis Work	:	Drying; Solar dryer; hybrid dryer; Latent heat storage

SHORT ABSTRACT

In this study, a hybrid solar dryer consisting of a solar air heater panel, a latent heat storage module, a blower, and a drying chamber has been developed. Performances of the solar dryer has been tested by drying some of the agricultural products available in the prevailing weather conditions of the North - Eastern part of India. The preliminary experiments on the dryer were carried out without the thermal energy storage material. The first experiment was performed to study the drying kinetics of the of Ghost chilli. A comparative study was also made by drying the products simultaneously in the open sun. The Ghost chilli samples were dried from its initial moisture content of 85.5% (w.b.) to the final moisture content of 10.5% (w.b.) in 123 h and 193 h in the developed solar dryer and the open sun, respectively. The moisture ratio data obtained from the drying experiment was used to perform non - linear curve fitting with eleven thin layer drying models available in the literature. The best model was chosen based on the criteria of the highest value of the coefficient of determination, and the lowest values of the reduced chi - square and the root mean square error. Among the eleven drying models, the Page and the Modified Page models for the open sun drying and the Midilli and Kucuk model for the solar dryer drying were found to be the most suitable drying models representing the drying process of the Ghost chilli. The effective moisture diffusivity of the solar and the sun dried products was estimated by graphical method. It was found to be 3.37×10^{-6} (m^2/s) and 2.04×10^{-6} (m^2/s) for the solar drier drying and the sun drying of the Ghost chilli, respectively.

The second experiment was performed to carry out energy and exergy analyses of the drying process of the Ghost chilli and the sliced ginger. Nine kg of Ghost chilli and 13 kg of sliced ginger were dried in the dryer separately. The moisture content of the Ghost chilli was reduced to 12% (w.b.) from its initial moisture content of 85% (w.b.) in 42 h at the drying air temperature range between 42 ºC and 61 ºC and the air flow rate of 0.02 kg/s. The moisture content of the sliced ginger was reduced to 9% (w.b.) from its initial moisture content of 87% (w.b.) in 33 h at the drying air temperature range between 37 ºC and 57 ºC at the same mass flow rate. The thermal efficiency of the first solar air heater was in the range of 22.1– 40.2% and was found to be higher than that of the second solar heater (connected in series with the first one) in the range of 9.6–19.5%. The specific energy consumptions of the Ghost chilli and the ginger were found to be 18.7 kW h/kg and 8.8 kW h/kg, respectively. The overall efficiency of the dryer was found to be different for different products. It was 4% for the Ghost chilli drying and 8.5% for the sliced ginger drying. The exergy efficiency of the drying chamber was in the range of 21–98% with an average of 64% for the Ghost chilli drying, and it was in the range of 4–96% with an average of 47% for the ginger drying.

In the third experiment, the shell side of the shell and tube heat exchanger of the thermal energy storage module was filled with 34 kg of paraffin wax of having average melting temperature of 58 ºC, and the dryer was tested by drying a local variety of red chilli. The red chilli was dried in the temperature range of 35–61 ºC with an average of 50 ºC. The moisture content of the chilli was reduced from 73.5% (w.b.) to 9.6% (w.b.) in 40 h. The dryer was operated daily for 10 h from 8:00 h to 18:00 h. The performance of each component of the drying system was evaluated by the energy and exergy analyses. It was found that the exergy efficiencies of the first and the second solar heaters were 0.9% and 0.8%, respectively. The energy and exergy efficiencies of the latent heat storage unit varied between 36.4% and 42.2% and 13.7% and 17%, respectively. The exergy efficiency of the drying chamber was found to be in the range of 24.3% and 98.1% with an average of 52.2%. The specific energy consumption of the red chilli and the overall efficiency of the drying system were found to be 6.8 kW h per kg of moisture and 10.8%, respectively. The electrical energy consumption in the dryer (running the blower) was found to be 0.7 kW h per kg of moisture which was only 10.3% of the specific energy consumption. The dryer was also tested by drying green chilli. The drying of the green chilli was accomplished successfully. Economic analysis of the dryer was carried out employing annualised cost method. It was found that the cost of the product dried in the solar dryer was Rs.42.7 and that of the same product dried in the electric dryer was Rs. 81.4. Qualitatively, the colour of the agricultural products dried in the solar dryer was found to be better than that of the same products dried in the direct open sun.