UNIVERSITÄT HOHENHEIM

INSTITUTE OF AGRICULTURAL ENGINEERING
Tropical and Subtropical Group

Prof. Dr. Joachim Müller

Master of Science

Agricultural Science in the Tropics and Subtropics

Natural Resource Management

Marcelo Figueira de Mello Precoppe

Performance Analysis of a Litchi Drying System in the Upland Region of Northern Thailand

This work was financially supported by the Eiselen Foundation Ulm

Date of delivery: 30.09.2008

SUMMARY

Litchi chinensis (Sonn.) is a tropical highland crop from Southeast Asia. More than 95% of the world production is located in the Asia-Pacific region. In Thailand, litchi is an important fruit crop, produced mainly by smallholders in the northern regions. Litchi is highly perishable and, for this reason, drying and canning are the most commonly used post-harvest techniques. A middleman-controlled market and litchi price decline have been forcing growers to change their land use type. In the upland region, given the steepness of the terrain, the conversion of the orchards to vegetable gardens imposes a serious threat to soil and water conservation. In order to promote the maintenance of the local litchi fields, the SFB 564 "Research for Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia" has been supporting litchi drying efforts at the Mae Sa Noi Lychee Farmers Cooperative. The farmers belong ethically to the Hmong people and grow litchi in the upper part of the Mae Sa watershed, Chiang Mai province. They have been drying litchi since 2007 using a hot-air cabinet tray dryer produced by Likhitchewan Co., Ltd., a local manufacturer of drying equipment. The dryer capacity, simplicity and price are suitable to litchi farmers - allowing them to enfranchise apart from the middlemen. In order to improve the energy efficiency and the product quality of the Likhitchewan dryer, the present study analyzed its performance and the drying behavior of the litchi bulk at the Mae Sa Noi Lychee Farmers Cooperative.

Pre-experiments were performed without litchis to determine the heat and air distribution inside the bulk and to calculate the air recirculation ratio. Additionally, four experiments with litchi were conducted where heat distribution, product quality and dryer efficiency were assessed. Air speed, temperature and relative humidity were measured and recorded. Fuel and electricity consumption were also monitored. Samples were collected approximately in 2-hour intervals for color, water activity and moisture content evaluation.

Litchi drying experiments lasted approximately 15.5 h. The average air temperature and relative humidity inside the bulk was 63 °C and 25%, respectively. Vertically, lower air velocity and divergent air temperature and relative humidity at the top and bottom of the bulk were measured. Horizontally, no significant differences in temperature and relative humidity were found across the trays. Farmers were able to achieve uniform end product quality by removing trays out of the dryer at different times or by not using the top and bottom tray positions. Average moisture content of the final product was 29% (wet basis), water activity 0.57, L value for lightness of 57 and hue angle of 80°. About 0.9 kg of LPG was required to produce 1 kg of dried litchi. The average thermal and system efficiency obtained was 25% and 24%, respectively. The dryer had an air recirculation ratio of 44% and consequently 53% of the total energy input was exhausted through the outlet. Losses were about 31%.

Efficiency and product quality can be improved by insulating walls and ducts and by regulating the air velocity inside the bulk. Increasing the air recirculation ratio can also improve the efficiency, but might jeopardize product quality, requiring further studies.