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Thesis

Performance investigation of a Taiwan type flat bed dryer currently used for longan (*Dimocarpus longan* Lour.) in Chiang Mai, Thailand.

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ABSTRACT

Dimocarpus longan (Lour. Sapindaceae), commonly known as longan, is one of the six species of the genus *Dimocarpus* that grow in tropical and subtropical conditions. It is commercially cropped in Australia, China, Taiwan, Thailand, USA and Vietnam. The most commonly cultivated variety of longan is *Dimocarpus longan* spp. *longan* var. Longan.

Thailand is currently the largest exporter of longan in the world. The high demand for longan in recent years has pushed longan prices higher. Thai farmers prefer to grow longan rather than lychee, because it is considered more profitable.

In 2003, Chiang Mai was the largest longan producer in Thailand by area, yield and productivity with 28,923 ha, 140,445 tons and 4.85 tons/ha respectively.

Longan is a fruit with high moisture content and it can only be stored for a short period of time at ambient temperatures. Drying the fruit reduces the weight to approximately one third of the original fresh fruit and it is well known that dried fruit has a longer shelf life in ambient conditions. Drying fruit allows transportation of larger quantities over longer distances at lower costs when compared to fresh fruit, also, drying the longan gives the product an added value.

Several dryers have been developed or modified and field-tested with different results and degree of acceptance by the local farmers. The most successful has been the Taiwan-type hot air ventilating dryer.

A good uniform drying process is required to achieve high end-product quality. In the Taiwan type dryer, drying bulks are loaded into the dryer in three layers separated by nets. Layers are rotated front to back (180°) and shifted from top to bottom. Rotating and shifting are performed so that each layer is dried at various levels and positions. Since the present design of the dryers does not allow for uniform drying, neither vertically nor horizontally, these techniques currently seem the best compensation available. However, it is believed that the process can still be further improved. More data on the process is needed, specifically an on-site characterization of the bulk drying behavior.

San Pa Tong village is one of the principal drying centers in the province of Chiang Mai, in Northern Thailand.

Four experiments were conducted in San Pa Tong with four different shifting schemes using only one dryer, which means that after shifting and turning, the longan was loaded into the same dryer every time. Drying air was maintained at 80°C. All experiments used class "B" fresh longan. Temperature, static pressure, relative humidity, air velocity, gas consumption, color and total moisture content were recorded.

Average temperature in the air heater outlet for Experiment 1 was 79.44 °C, for Experiment 2, 78.94 °C and for Experiment 3, 79.24 °C. Maps of heat distribution were made for the top and bottom of the drying bulk as well as between layers. A three dimensional view of heat distribution within the bulk can be made for any time during the drying process. Results show that within the layers the horizontal temperature distribution is more uniform on the bottom, but as we move up the heat distribution is less homogenous. The average temperature drop between bottom and top layers for Experiment 1 was 22.85°C, for Experiment 2 was 21.15°C and for Experiment 3 was 21.35°C. Temperature difference is not constant during the drying process; it tends to decrease as the drying process advances.

Static pressure remains constant regardless of temperature, or time.

Air velocity is not homogeneous, the far side has higher air velocity and the near side has lower air velocity due to differences in velocity pressures inside the air plenum. Different air velocity has an impact on temperature distribution due to higher heat exchange rate. This results in a not uniform drying in the horizontal perspective. Maps of air velocity distribution were made.

The end product data show that the color was not homogeneous. Only Position 5 had the same color as the standard. All samples at the corners, except for C3, had significantly higher hue values when compare with the standard sample.

Total moisture content at the beginning of the experiments was in average 73%. The end products, however, were not uniform. When comparing all samples to the standard sample, we realize that only the samples in the center and the far side of the dryer did not show significant differences. The average end moisture content of the longan was 19.3% for Experiment 1; 16.9% for Experiment 2; 14.5% for Experiment 3 and 17.0% for Experiment 4. The standard had an average TMC of 14.7%.

In the overall perspective it was found that Experiment 3 was the most successful in terms of end product quality.

Previous studies have reported optimum shifting would be from 6 to 12 hours. Due to the labor requirements and the size of the industrial dryers, this time is not applied in reality. Instead, 24-hour intervals are used and found to be optimal in terms of product quality, labor time and costs.

To obtain a uniform product in the Taiwan-type flat bed dryer the main issue is to create a uniform air velocity in the bulk. As a result, this will produce, uniform temperature distribution and a more uniform product, at least in the horizontal plane.

Future studies should focus on energy savings methods and techniques to reduce damage to the fruit since those are the main concerns of the owners of longan drying facilities.