PROJECT REPORT

on the

PERFORMANCE EVALUATION OF THE HOHENHEIMER SOLAR TUNNEL DRYER UNDER PHILIPPINE CONDITIONS

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EXECUTIVE SUMMARY

Sundrying is the cheapest and most practical method of drying agricultural and marine products. This drying method, however, is unhygienic because of the products exposure to dust, flies, microorganisms, and other contaminants that affect their quality. Also, due to the unpredictable weather conditions, drying is always interrupted during rainy days resulting to the production of low quality dried products. The traditional problems associated with sundrying encouraged the Institute for Agricultural Engineering in the Tropics and Subtropics (IAETS) of the University of Hohenheim at Stuttgart, Germany, to develop a solar tunnel dryer for drying fruits and other similar products for adoption in tropical countries. The said dryer is now manufactured and promoted by INNOTECH Gmbh, Germany. As part of its promotion in the Philippines, the University of Hohenheim, through the efforts of Prof. Dr.-Ing. Werner Muehlbauer, Director of IAETS, and the financial support from the DAIMLERCHRYLER and the Father and Son Eiselen Foundation of Germany; in collaboration with the Visayas State College of Agriculture (ViSCA), installed a prototype of the dryer at the Department of Agricultural Engineering and Applied Mathematics (DAEAM), primarily for drying fruits and for its eventual promotion in the country.

Being an agricultural country, a number of agricultural products, other than fruits, can be possibly dried using the solar tunnel dryer. Thus, to increase its potential for adoption in the Philippines, a number of studies were conducted to evaluate the performance of the solar tunnel dryer. These studies included the drying of sweetpotato chips, cassava chips, abaca fibers, and fish. This report presents the results of the drying experiments conducted using the solar tunnel dryer. The studies were conducted between the rainy months of October 2000 to February 2001 at ViSCA, Baybay, Leyte, Philippines.

PART 1 covers the results of the drying experiment of sweetpotato chips. The study was conducted to determine the drying characteristics of sweetpotato chips measured in terms of the instantaneous moisture content and drying rate; evaluate the physical characteristics of the dried sweetpotato chips; and compare the performance of the solar tunnel with the laboratory dryer and sundrying. The drying experiments were conducted following a single factor experiment in randomized complete block design with loading density (2, 4, 6, and 8 kg/m^2) as the factor and the section of the solar tunnel dryer (front, middle, and back) as the blocking variable. The ViSCA VSP5 sweetpotato variety was used in the study. Results of the study indicated that the instantaneous moisture content and the drying rate of sweetpotato chips were significantly affected by the loading density throughout the drying process. The higher the loading density, the slower was the removal of moisture from the chips or vice versa. Similarly, the smaller the loading density, the higher was the drying rate or vice versa. The different sections of the solar tunnel dryer did not affect both the instantaneous moisture content and the drying rate throughout the drying process. The time required to reach the desired moisture content of 14%, wet basis, was faster in the solar tunnel dryer than in sundrying by at least 2 hours. The color of the dried chips produced in the solar tunnel dryer was of superior quality. For a day drying to reach the desired moisture of 14%, wet basis, using the tunnel dryer, a loading density of 6 kg/m^2 was found appropriate.

PART 2 presents the results of the study conducted to determine the drying characteristics of abaca fibers, expressed in terms of the instantaneous moisture content and drying, using the solar tunnel dryer, and compare the tensile strength of abaca fibers dried in the solar tunnel dryer and directly under the sun. The experiment was conducted using a 2 factor- factorial experiment in RCBD with the kinds of leafsheaths (inner, middle, and outer) and loading density (1, 2, and 3 3kg/m^2) as factors. Results of the study indicated that the instantaneous moisture content of fibers was significantly affected by the leafsheaths during the first two hours of drying. Similarly the different loading densities significantly affects the instantaneous moisture content during the whole duration of the drying process. The different sections of the solar tunnel dryer and the interactions between the kind of leafsheaths and different loading densities did not have any significant effect throughout the drying process. In terms of the tensile strength, fibers dried under the sun was found to be stronger than those dried in the solar tunnel dryer. The tensile strength of the outer leafsheaths was the strongest followed by the middle and the inner leafsheaths, in that order. The drying time to reach the desired moisture content of 14%, wet basis, was shorter by one hour in the solar tunnel dryer than sundrying of 3 hours and 4 hours, respectively using a maximum loading density of $3kg/m^2$.

PART 3 shows the results of the studies conducted to determine the effects of soaking time and type of salt solution on the drying characteristics of fish dried in the solar tunnel dryer, measured in terms of the instantaneous moisture content and drying rate of fish; and to evaluate the quality of the dried fish. The drying experiments were conducted following a 2 x 3 factor-factorial experiment in a randomized complete block design with soaking time (1, 2, and 3 hours) and type of salt solution (with and without spices) as factors. The dryer section served as the blocking variable. The Hasa-hasa (Rastrelliger neglectus) type fish, with an average weight of 280 grams each, was used in this study. The instantaneous moisture content and the drying rate of Hasa-hasa did not differ at the different sections of the solar tunnel dryer throughout the drying process. In contrast, the salt solution used and soaking time significantly affected the instantaneous moisture content and drying rate. The drying time of fish to reach the desired moisture of 15%, wet basis, was shorter when dried in the solar tunnel dryer than in the laboratory dryer or under the sun. The sensory qualities of aroma and taste of the dried fish were not affected by type of salt solution and soaking time. The texture and flavor were found to be significantly improved when soaked with salt solution containing spices for 2 to 3 hours before drying.

In terms of the efficiency of the dryer to increase the temperature of the ambient air to the drying air temperature, results indicated that the solar tunnel dryer is capable of increasing the ambient temperature by as much as 75-100%, depending on the intensity

In general, the results of the performance evaluation of the solar tunnel dryer in drying rootcrops, abaca fiber, and fish indicate that the dryer offers the best alternative to sundrying in producing high quality dried products, in addition to the drying of fruits, spices, and medicinal plants. It is suitable for adoption under Philippine conditions where the weather is very unpredictable. The plastic cover of the dryer ensures a continuous drying process of any commodity without being interrupted by a sudden occurrence of rain. The photovoltaic panels provide a cheap source of motive power to run the blowers of the dryer even on cloudy days. However, under Philippine conditions, a number of modifications needs to be incorporated to make the dryer more suitable for processing various agricultural and marine commodities. The following modifications are then suggested:

1. There is a need to have separate removable drying trays with the corresponding tray guides. These trays facilitate the pre-drying processes for almost all types of products.
2. In most places in the Philippines, there is no distinct dry and rainy seasons. Rain just come anytime that greatly affects the drying process. There is therefore a need to incorporate supplemental heating system (i.e., LPG-fueled or electricity generated) to provide energy during rainy days and at nighttime.

3. During heavy rainfall, the supports of the plastic cover collapse. Thus, there is a need to provide vertical support in the middle of these supports to make them stronger.

4. In areas where grid electricity is available, a motor driven blower may be used instead of the photovoltaic panels which are relatively expensive and therefore requires higher initial capital.