A SOLAR-BIOMASS DRYER FOR PINEAPPLE[1]

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ABSTRACT

Pineapple is one of the major fruit exports of the Philippines. For most pineapple farmers, its production has always been the major source of livelihood. In Camarines Norte, one of the major pineapple producers, the variety that grows is the Formosa. Small-sized fruits, which are about 10 percent of the production, are usually discarded and left to rot on the field. The development of the solar-biomass dryer has given the farmers an opportunity to process these surpluses i.e. to market dried pineapple products.

The dryer has the following major components: (1) drying chamber, (2) biomass-stove, and (3) solar collector. The dryer has a capacity of 50-kg sliced pineapple fruits per batch. With drying air temperature set at 60°C, pineapple from an initial moisture content of 85% can be dried to a final moisture content of 20% wet basis for about 18 hours consuming 2.0 kg per hour of coconut shell/ wood charcoal. The solar collector can be used whenever solar insolation is available. Preliminary quality evaluation indicated positive acceptance of the dehydrated pineapple produced.

The dryer can also be used for other agricultural products such as mango, banana and other herbal leaves. This study is being supported by the Swedish International Development Cooperation Agency through the Renewable Energy Technologies in Asia Programme of the Asian Institute of Technology.

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1. INTRODUCTION

Pineapple is one of the most popular fruits in the Philippines. In fact, practically all regions in the country produce an appreciable amount of pineapple with Northern Mindanao region as the top producer.

Camarines Norte has also a considerable amount of pineapple, having a volume of about 20,900 metric tons from an area of 2,210 hectares (BAS, 1999). This makes them the fourth top pineapple producer in the country.

The province of Camarines Norte is popularly known for its Queen or Formosa variety, a small-sized sweet-tasting fruit that weighs to about 0.45 to 0.95 kilogram. It has a deep yellow color and a crisp texture.

For most farmers in this area, pineapple production has always been the major source of livelihood. The farm gate price of fresh pineapple fruit is Php 4 per piece and is sold at about Php 6 per piece in the market. However, the fist-sized pineapple fruits that are produced, estimated to be about 10 percent of the production, are a major problem for the farmers. Fruits of this size are usually discarded and left to rot on the field thereby decreasing their income.

In response to the above problem, the University of the Philippines Los Baños in collaboration with the Asian Institute of Technology under the project "Drying Systems for Rural and Urban Poor" developed a solar-biomass dryer for pineapple. It aims to help the farmers in the area developed an alternative solution to their surpluses through marketing of dried pineapple products.

The prototype solar-biomass dryer was installed at the MSS (Maliliit na Sambayanang Simbahan) Multi-Purpose Cooperative compound in Camambogan, Daet, Camarines Norte.

The dryer can also be used for other agricultural products such as mango, banana and other herbal leaves.

2. PROJECT OBJECTIVES

The general objective of the project is the development, demonstration and dissemination of agricultural multi-commodity drying systems using renewable energy resources for rural-based communities. Some of the specific objectives are:

1. Develop and demonstrate solar/biomass multi-commodity drying systems at selected rural-based communities;
2. Identify and categorize the market potential for both drying system and dried products; and
3. Provide a strategic plan for the commercialization of the multi-commodity drying system.

3. DESCRIPTION OF THE SOLAR-BIOMASS DRYER

The solar-biomass dryer shown in Figure 1 has three main components: (1) drying chamber, (2) solar collector, and (3) biomass furnace.

The dryer intends to maximize the use of energy available from the sun and utilize agricultural wastes.

A. Drying Chamber

The drying chamber is a cabinet type with a designed capacity of 50 kilograms sliced pineapple fruit. It is made up of galvanized iron sheet metal with gauge 16 size framed by angular bars of sizes ranging from 1/8" x 1" to 3/8" x 1-1/2".

The chamber accommodates a total of 30 trays made up of aluminum wire screen. A 12" fan with an air flow rate of 330 cfm is positioned at the exhaust portion of the dryer.

B. Biomass Gasifier Stove

The gasifier stove, which is fueled by coconut shell/ wood charcoal, is composed of four main components: fuel storage hopper, reaction chamber, primary air inlet and combustion chamber.

The hopper is positioned vertically on top of the reactor where producer gas is produced. An ash collector is provided at the bottom of the reaction chamber. A primary air inlet is attached at one side of the reactor, which supplies air to the chamber. On the opposite side is the combustion chamber where the gas produced in the reactor is burned and flue gas is generated. A sliding plate is provided at the bottom of the combustion chamber for the supply of secondary air needed for combustion.

The biomass gasifier stove, adapted from the Asian Institute of Technology, is designed to provide a drying air temperature of about 60°C. The temperature can be controlled through a sliding plate provided in the duct that connects the chamber and the furnace.

C. Solar Collector

The solar collector is a flat plate type with a dimension of 90 cm x 12 cm. It has an air collection gap of 5 cm and an insulation of about 8 cm thick. The absorbing surface, which receives insolation, is a matte black painted metal sheet. A single Plexiglas cover with a thickness of 1/8" is placed above the absorber.

The collector, which is attached at the backside of the drying chamber, is oriented at an angle of 15°. The fan inside the chamber forces the ambient air to pass through the collector and rise up to the load.

4. RESULTS AND DISCUSSION

4.1. Drying Experiments

Drying tests were conducted at the MSS compound during the period of October 2000 and March 2001.

The drying tests however were carried out using the biomass gasifier stove only due to unfavorable weather conditions at the said area.

Fresh pineapple fruits with a total weight of 89 kilograms were peeled and sliced by two trained workers for about one and a half hours. A recovery of about 31% was obtained reducing to a total weight of 28 kilograms sliced pineapple fruits. The sliced samples were dried for 18 hours from a moisture content of 85% w.b. down to 20% w.b. at an average drying air temperature of 60°C. No preservatives were added to the pineapple samples. Figure 2 shows the drying curve of pineapple during one of the drying tests.

The drying operation consumed 37 kilograms of coconut shell/ wood charcoal. A recovery of about 6 kilograms dried pineapple fruit was obtained.

During the operation, however, non-uniformity in drying was observed. The samples located in the lowest and uppermost layers dry faster. Louvers at the side of the chamber are recommended.

4.2. Sensory evaluation

A sensory evaluation on dried pineapple samples was also done to determine its acceptability to consumers. Three different samples were presented to ten consumers; i.e. (a) dried pineapple fruit from the solar-biomass dryer, (b) dried pineapple fruit sold in the supermarket, and (c) pineapple chunks. Samples were evaluated based on its sweetness, color, chewiness and overall acceptance.

Based on the analysis of variance (ANOVA) at 5% level of significance, the three samples are not significantly different with regards to chewiness and overall acceptability. From a range of 1 to 10, with 10 rated as like extremely, overall acceptability showed an average rate of 7 for the samples sold at the supermarket while an average rate of 6 was obtained in

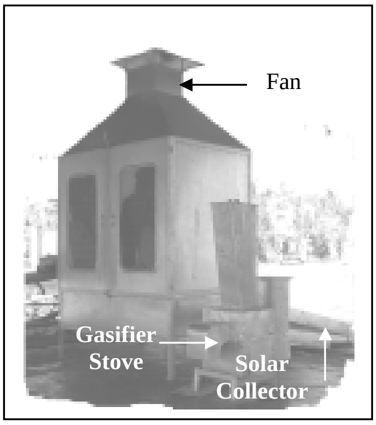

Figure 1. The solar-biomass dryer

the two other samples. The same rate was obtained for chewiness.

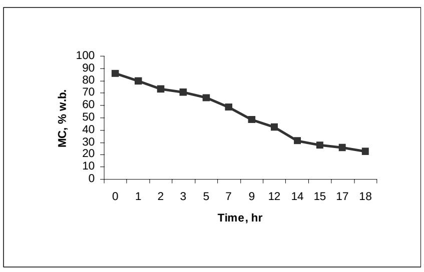

Figure 2. Pineapple Drying Curve

All treatment means were compared using the Duncan's Multiple Range Test (DMRT). Results showed that in terms of sweetness and color, consumers prefer the dried pineapple fruit sold in the market. An average rate of 7.1 was obtained for the dried samples in the market while 6.2 and 4.6 were obtained in the solar-biomass dried samples and pineapple chunks, respectively. At 5% level of significance, the dried pineapple in the market however is not significantly different from the solar-biomass dried pineapple with regards to sweetness. But considering the color, the latter sample needs further enhancement. An R-square of 0.34 and 0.38 were obtained for the sweetness and color attribute, respectively.

4.3. Cost Analysis

A simple costs and returns analysis was computed using the following assumptions: (1) 150 batches per year; (2) cost of pineapple fruit is Php 4 per piece; (3) cost of fuel is Php 50 per bag; (4) Dryer operator cost is Php 250 per batch; (5) cost of laborer is Php 60 per hour per person; (6) cost of dried pineapple is Php 19 per 100-gram; (7) Electricity cost is Php 5 per kWh; (8) Depreciation is straight-line method; (9) Repair and maintenance is 8% of investment cost; and (10) Interest rate is 18%; and (11) an investment cost of Php 56,000.

Based on the above data, a return on investment (ROI) of about 50.41% and a payback period of two years are expected.

5. CONCLUSION

The solar-biomass dryer can dry a maximum of 50 kilograms of sliced pineapple fruit from a moisture content of 85% w.b. down to 20% w.b. for 18 hours. Based on a recovery rate of 20%, ten kilograms of dried pineapple fruit per batch is expected.

As shown from the results of the sensory evaluation, the dried fruit from the solar-biomass dryer is acceptable to consumers and comparable to the dried pineapple fruits in the market. The color or appearance of the product however still needs further improvement. On the other hand, the problem in non-uniformity of drying can be resolved by adding louvers at the side of the drying chamber.

The development of the solar-biomass dryer will save the fist-sized pineapple fruits from being disposed of. Proper marketing of the dried product will add up to the income of farmers. A payback period of two years is expected.

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