QUALITY ENHANCEMENT OF DEHYDRATED PRODUCTS THROUGH THE MODIFICATION OF SOLAR TUNNEL DRYER FOR CONTINUOUS OPERATION IN RURAL COMMUNITIES

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ABSTRACT

The objective of the study was to develop supportive solar dehydration technologies to change the drying system of perishables from traditional sun drying to hygine solar dehydration in rural communities. The prototype solar tunnel dryer developed by the University of Hohenheim, showed direct and indirect drying and least resistance to horizontal airflow compared to cross air flow in a vertical rack-types dryer. Ease of loading and unloading, visibility of drying product through the clear cover of the drying bed, ease of cleaning and the simplicity of the structure compared to the other solar dryers were the other selection criteria. The daily output of a proto-type solar tunnel dryer was increased by attachment of a supplementary heating source. A prototype solar tunnel dryer was built at the Industrial Technology Institute (ITI) premises and performance tested. The dryer showed best performance at noon when peak temperature development occurred at 60°C to 65°C of an average sunny day. A maximum temperature development of 75°C to 80°C was observed and on hot sunny days. There was a minimum temperature variation of 5°C along the drying bed. However, the temperature development during the morning and evening was below the optimal temperature for drying of pineapple, mango, papaya, jak fruit and mushroom product i.e. 45°C to 60°C. Dryer showed the required reduction of moisture content of jak fruit and brinjal after a drying time of 3 to 4 days. The extended drying time also resulted in loss of product quality. The dryer essentially needed a supplementary heat source to reduce drying time. This was achieved via continuous day and night operation at optimum drying temperatures. The factors such as maturity stage, thickness and shape of slices, pre-treatments and best temperature for the solar dehydration of pineapple, papaya, mango and jak fruit were optimized using an electric dehydrator prior to carrying out the modification. Pre-treatment combinations and temperature for solar dehydration

of mushroom were also optimized. There was no significant difference ($p>0.05$) between fresh and dehydrated mushroom of non-treated and treated samples in relation to energy, protein, fat, crude fiber, carbohydrate, ash and iron content except significant loss ($p<0.05$) of ascorbic acid content in dehydrated form compared to fresh mushroom.

A model heating unit was placed in-between the collector and drying section, which consisted of a burning chamber, heat exchanging plate, removable roof and a chimney. Combustion of sawdust in two improved barrel stoves of 40cm diameter, 60cm height and 60cm diameter, 70cm height capacity were the most suitable to operate the heating unit. By changing sizes and number of stoves, maintaining airflow rate at $0.08m^3s^{-1}$ during night and gradual increment of $0.22m^3s^{-1}$ from morning to noon, the temperature and relative humidity development of the dryer was controlled to match with required drying air temperature. Reduced drying duration from 1 to 1.5 days for different products to their safe storage level was obtained by carrying out a series of test trials. Physico-chemical, organoleptic and microbiological parameters of five dehydrated products showed that the modified solar dehydration system was capable of eliminating off- flavours commonly produced in traditional sun drying and other solar dehydration systems. Shelf life trials of pineapple, papaya and mango using suitable packaging materials showed that products could be stored at ambient temperature for up to three months while storage at 13°C increased the storage period to more than four months. Moisture sorption study showed that dehydrated products should be stored at low temperature and low humidity conditions to maintain quality.

Field trials run with users in rural areas indicated that the modified solar drying system was suitable for adoption in areas of Sri Lanka having dry and intermediate climates.