

A Versatile Solar Dryer for Coconut

Abstract

Drying is an important post-harvest operation in the processing of coconut for extraction of coconut oil. Fresh coconut kernel containing 45- 55 per cent moisture content (M.C.) has to be dried to 5- 6 per cent moisture level in order to obtain good quality copra. The common practice of getting copra is by sun drying the fresh coconut kernel on cement floor or on sand floor for seven to nine days. Unlike other crops, while drying, the endosperm of coconut is exposed and so is susceptible for contamination due to dirt. Prolonged drying also results in microbial infection. Drying using solar dryers and indirect dryers produce good quality copra in a shorter time. So a solar tunnel dryer with a capacity of 1500 coconuts / batch was developed. It consists of a semi cylindrical shape tunnel structure having a transparent cover made from UV stabilized polyethylene film of 200-micron thickness. The floor area of the dryer is 3.5 x 3 sqm and the radius of the tunnel is 1.5 meter. The solar collector is the black polyethylene film of 250-micron thickness spread on the ground inside the dryer for better absorption of solar heat. The temperature inside the dryer is 20 - 25°C higher than the ambient and the R.H. value is 20 - 22 per cent lower than the ambient. Since drying is done continuously much above the ambient air temperature and at lower R.H. level, the copra is 3 - 4 times less infested by fungi and bacteria than that produced by open sun drying. Drying time taken to dry copra is 32 sunshine hours. The cost of the dryer is Rs 13650 and the cost of drying one kg of copra is Rs. 1.25. The dryer can also be used to dry other plantation crops produces.

Introduction

Drying is an important post-harvest operation in the processing of coconut for extraction of

coconut oil. Fresh coconut kernel having 45 to 55 percent moisture content (w.b) has to be dried to 5 - 6 percent moisture level in order to obtain good quality copra. Drying must be carried out within four hours of nut splitting since coconut kernel deteriorates very rapidly due to growth of mould and bacteria (Patil, 1991). Within four hours, microbial activity in the form of slime, due to bacterial growth is seen if temperature is less than 30°C and relative humidity is more than 80 percent. The surface slime continues to develop within 4 - 8 hours. Microbial activity is reported as more, if the moisture content of the kernel is above 20 per cent. (Nair, 1984). It is also reported that the fungi is also the principal agent causing deterioration of copra followed by bacteria. Nathaneil (1965) found that the loss due to microbial infection varies with moisture content of dried copra. T. Subrahmanyam (1968) recorded the occurrence of *Staphylococcus aureus*, *Bacillus* sp. and yeast at 20 -50 percent moisture content of copra. George V Thomas *et al* (1987) reported that deterioration of copra started during drying and aggravates

during storage. Bacterial action is initiated during processing and the severity of subsequent mould infection and insect attack depended on the extent to which the cell structure has been broken down by the bacteria. The common practice of getting copra is by sun drying the fresh coconut kernel on cement floor or on sand floor for seven to nine days. Unlike other crops, while drying, the endosperm of coconut is exposed and so is susceptible for contamination due to dirt. Prolonged drying also results in microbial infection. The microbial contamination can be reduced if drying is done more quickly in suitable dryers. Drying using solar dryers and indirect dryers produce good quality copra.

Solar drying relies on the sun as the source of energy. It differs from sun drying in that a structure is used to enhance the effect of insolation. Compared with sun drying, solar dryers can generate higher air temperature and consequential lower relative humidity, which are both conducive to improved drying rate and lower final moisture content of the dried crop. As a result the risk of spoilage is reduced both during the actual process and subsequent storage. The higher temperatures attainable are also a deterrent to insect and microbial infestation. Additionally protection against dust, insects and pests is enhanced by drying in an enclosed structure.

Materials and Methods

The dryer was designed to dry 1500 coconuts per batch. The dryer consisted of a semi cylindrical shape tunnel structure having a transparent cover made from UV stabilized polyethylene film of 200-micron thickness. The floor area of the dryer is 3.5 x 3 sqm and the radius of the tunnel is 1.5 m. The solar collector is the black polyethylene film of 250-micron thickness spread on the ground inside the dryer for better absorption of solar heat. A gradient of 10° to 12° has been provided along the length of the tunnel to induce natural convection airflow. Thermocol insulation having 10 cm thickness is provided below the black sheet to prevent heat loss through the floor. Inlets for fresh air have been provided along the periphery of the tunnel near the ground level. Two chimneys 20 cm diameter and 75 cm height have been provided on top of the curved surface to allow exhaust of hot moist air. In order to prevent condensation of moist air during night hours and for better heat distribution an exhaust fan of 0.2 m³/s capacity was fixed. The solar dryer is fixed with its curved surface facing north-south direction to have

maximum insolation. Two trolleys of 3.4 meter length and 1.2 meter width at the bottom and 90 cm width at the top having trays to keep the coconut for drying are provided. This can be drawn out to load the coconuts or other produce and pushed inside for drying. The design drawing and the photograph of the dryer is given separately below.

Results and discussion

The solar collector and the iron trolley kept inside absorb the sunlight entering inside the tunnel dryer which in turn emit long wave thermal radiation and the polyethylene cover sheet will not allow it to pass through it. As a result, the solar energy is trapped for raising the temperature inside and used for drying the kernel kept inside. The testing of the tunnel dryer was carried out with coconut. 1500 nuts were loaded in the trolley and pushed inside the drying chamber. After 15 hours of solar drying, the kernel was shrunk and shell was partially detached from the kernel. At this stage the shell is removed manually and the kernel is further dried. It took another 17 sunshine hours for the kernel to be dried completely. The variation in

temperature and relative humidity of ambient air and air inside the drying chamber are shown in Fig.1 for first day, Fig.2 for second day and Fig. 3 for third and fourth day of drying. The variation in moisture content of copra with respect to the drying time is shown in Fig.4 and the design drawing of solar tunnel dryer is given in Fig.5. When the ambient air temperature varied from 26°C to 33.5°C the drying air temperature was increased to 45°C to 55°C. The same way the RH inside the drying chamber was reduced by 20 per cent. The copra dried in the solar tunnel dryer and the control trial were analysed for its quality and the results were shown in Table 1. It can be seen that there is significant reduction in the population of fungi, bacteria and lipolytic micro-organisms in the copra samples dried with solar tunnel dryer when compared to that of sun drying. The optimum moisture level recommended for safe storage of copra is 6 per cent (w.b) and if the moisture content is high copra will be infected with bacteria, and fungi. Paul (1969), and Susamma, Menon 1981 isolated a number of fungi and bacteria from deteriorated copra. The fungi isolated were *R.stolonifer*, *R.oryzae*, *Mucor hiemalis*, *P.Citrinum*,

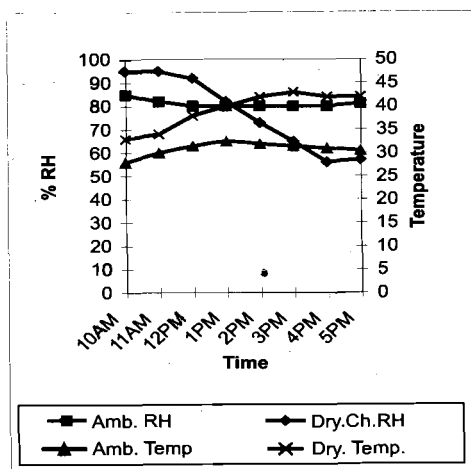


Fig. 1. Variation of RH & Temp. (I Day)

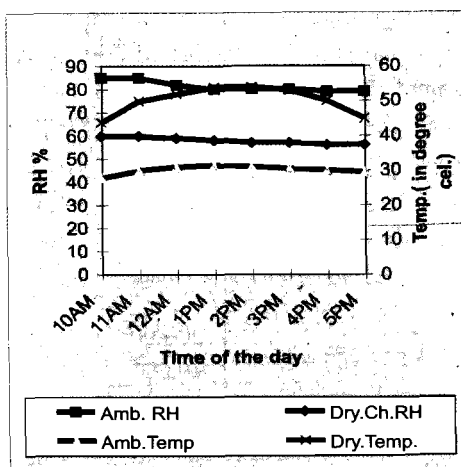


Fig. 2. Variation of RH & Temp. (II Day)

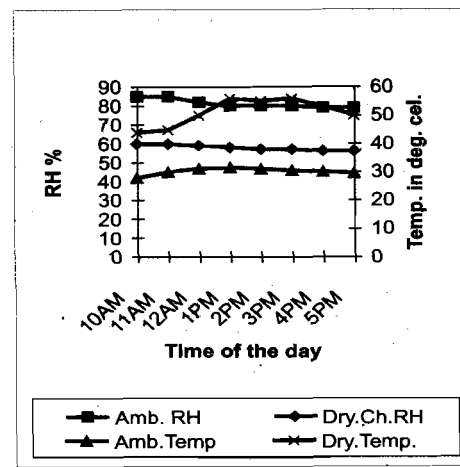


Fig. 3. Variation of RH & Temp. (III & IV Day)

Culvularia Senegalensis etc. Since the drying was done continuously much above the ambient air temperature and at lower R.H. level, the copra was free from fungi and bacteria. Moisture condensation during night hours is a serious problem in this type of closed structure dryers. So exhaust fan should run continuously day and night during drying period.

Economic analysis of the dryer:

The construction cost of the dryer
Table 1. Microbial analysis of copra

| Micro-organism (Number of colonies per g of sample) | Sun drying n=26 | Solar tunnel dryern=26 | t-Value |
|--------------------------------------------------------|--------------------|---------------------------|---------|
| Fungi (x100) | 6.6653 | 2.095 | 30.82** |
| Bacteria (x100) | 15.1481 | 4.42969 | 17.67** |
| Lypolitic micro-organisms (x100) | 3.93 | 1.2142 | 37.5** |

** significant at 1% level

Table 2 Economic analysis

| Assumptions: | |
|----------------------------------------------------------------|-------------------|
| 1. Capacity of the dryer | 1500 nuts / batch |
| 2. Cost of the dryer | Rs. 13650.00 |
| 3. Drying time | 32 sunshine hours |
| 4. No. of working days/year | 240 days |
| 5. Life of the dryer | 10 years |
| 7. No. of labourers required | 2 man days |
| 8. Cost of labour | Rs.100/ day |
| 9. Cost of electricity | Rs 2/ unit |
| 10. Quantity of copra from 1500 coconuts | 247.5 kg |
| 11. Fixed cost per year: | |
| Annual depreciation (10% of cost) | Rs. 1365/- |
| Annual Interest on half the new cost @ of 15% | Rs. 1024/- |
| Maintenance cost @ 10% of annual cost+ cost of polythene sheet | Rs1500/- |
| No of batches in a year | 60 |
| Total fixed cost / year | Rs. 3900.00 |
| Fixed cost/ batch | Rs. 65.00 |
| Variable cost : | |
| Cost of labour | 200.00 |
| Cost of electricity | 40.00 |
| Total variable cost | 240.00 |
| Cost of drying / batch | Rs. 305.00 |
| Cost of drying / kg. of copra | Rs. 1.25 |

along with trolley was estimated at Rs. 13650 and expected life of the dryer is 10 years. The straight-line method of depreciation is adopted to calculate annual depreciation. The interest rate is assumed at 15% per annum for the half initial cost as capital every year. With these assumptions and

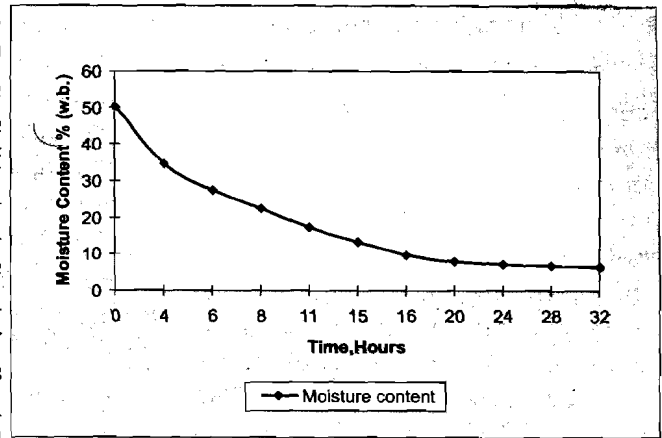


Fig. 4. Moisture reduction curve (coconut)

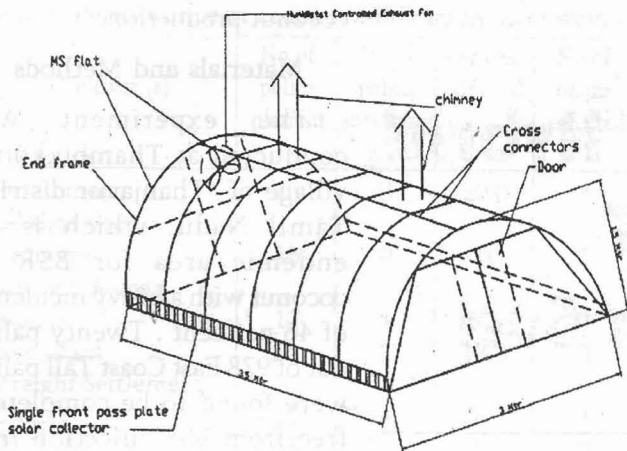
considerations cost analysis was done as given in Table 2. The cost of drying is calculated as Rs.1.25 / Kg of copra.

Conclusion

A solar tunnel dryer has been developed. It consists of a semi cylindrical shape tunnel structure having a transparent cover made from UV stabilized polyethylene film of 200-micron thickness. Since the drying is done continuously much above the ambient air temperature and at lower R.H. level, the copra is almost free from any microbial infection. Drying time taken to dry copra is 32 sunshine hours. The cost of the dryer is Rs 13650 and the cost of drying worked out for one kg of copra is Rs. 1.25 and This can be used by farmers of small and medium holdings to dry coconuts. The dryer can also be used to dry other plantation crops.

Reference

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Tunnel type solar dryer - inside and outside view

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International Seminar on Coconut in Goa

Coconut Development Board is organising an international seminar on coconut under the theme 'Global Coconut Industry-The future outlook' on 10th and 11th December 2005. The seminar will be co-sponsored by the Asian & Pacific Coconut Community. The seminar intends to bring all relevant persons on a common platform to discuss the concerns of the coconut community and formulate strategies for the future growth and economic empowerment of the coconut industry. A realistic assessment of the demand and projections of growth combined with a strategy for improving production and productivity, combating the high incidence of pests & diseases, harnessing the full potential for

product diversification and finding new applications for conventional products assume great significance in this context.

Papers on different topics will be presented by the invited speakers including those from the major coconut growing countries. Presentation of papers and deliberations will be in English.

An exhibition will also be organised in connection with seminar with the objective to promote various coconut products among the international level.

Registration fee for the participants in the seminar is Rs. 1,500 per person. The registration fee for accompanying spouse is Rs.750 for delegates from

India and US\$ 25 for delegates from outside India. The fee is payable as DD drawn on any Commercial Bank in favour of Seminar Committee, International Seminar on Coconut 2005 payable at Kochi - 682011, Kerala India

Venue of the Seminar is at

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