

SUN DRYING OF COPRA*

R. T. PATIL AND C. K. B. NAMBIAR

Central Plantation Crops Research Institute, Kasaragod-670 124, Kerala, India.

ABSTRACT

The suitability of different drying surfaces and a solar drier (cabinet type) was assessed for effective drying of copra. The saving in time was observed as 21%, 31% and 39% by solar cabinet drier over black painted palmyra mat, jute cloth, and cement floor respectively. Solar cabinet drier showed higher drying rate during falling rate period (0.003 kg of water/kg of dry matter/hour) and black painted palmyra mat showed a higher rate of drying during constant rate period (0.1433 kg of water/kg of dry matter/hour). The colour of the oil obtained from the copra dried in solar cabinet drier and on black painted palmyra mat was clear. Drying of copra on black painted palmyra mat at first and later in solar cabinet drier, is suggested for quicker drying and larger operating capacity of the solar cabinet drier.

INTRODUCTION

Annual production of coconut in India is about 5800 million nuts, 40% of which is converted into copra by drying (Thampan, 1976). Fresh meat contains about 85-90% water (dry basis) whereas moisture content required for oil extraction by the existing methods and for storage is only 6%. Sun drying is an age-old practice followed for drying most agricultural products. Fresh coconut meat requires drying before processing for oil extraction and also for prolonged storage. Usually, farmers expose the coconut meat to direct sun on mud floors for several days for drying the exposed moist coconut endosperm.

Coconut is grown in the tropical belt having plenty of bright sunshine hours throughout the year. Available

solar radiation at Kasaragod is about 400 cal/cm² from an average of 7.5 sunshine hours per day. This indicates the feasibility of using solar energy for drying agricultural produce (Anonymous, 1978). Average temperature, relative humidity, wind velocity and sunshine hours per day at Kasaragod are given in Table I (Anonymous, 1977).

Sun dried copra is considered to be of good quality. The term FMS (Fair Merchantable Sun dried) has long represented a standard of copra (Child, 1964; Gimmick, 1964). It has been reported that the best grade copra is obtained by drying meat in the sun for about 5-7 days. For edible grades of copra sun drying is preferred (Patel, 1938; Anonymous, 1960). Eligion 1929, (quoted by Patel, 1938) was of the

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Table I. Ambient day temperature, relative humidity (RH), number of sunshine hours and wind velocity at Kasaragod during 1977.

Month	Temperature °C	RH (%)	Sunshine hr/day	Wind velocity at 3.05 M, KMPH
January	31.4	69.5	10.0	3.3
February	31.6	76.0	9.6	3.4
March	32.8	75.5	9.3	3.8
April	33.3	73.0	9.7	3.6
May	32.3	75.5	7.2	2.7
June	29.8	87.0	3.5	3.1
July	28.5	90.0	2.0	3.7
August	29.1	86.5	4.9	3.2
September	29.7	83.0	6.9	3.9
October	31.5	81.5	6.7	2.5
November	30.8	83.0	6.1	2.6
December	32.8	67.5	9.7	2.6

opinion that sun dried copra is even better in quality and keeps longer than the copra produced in hot air drier.

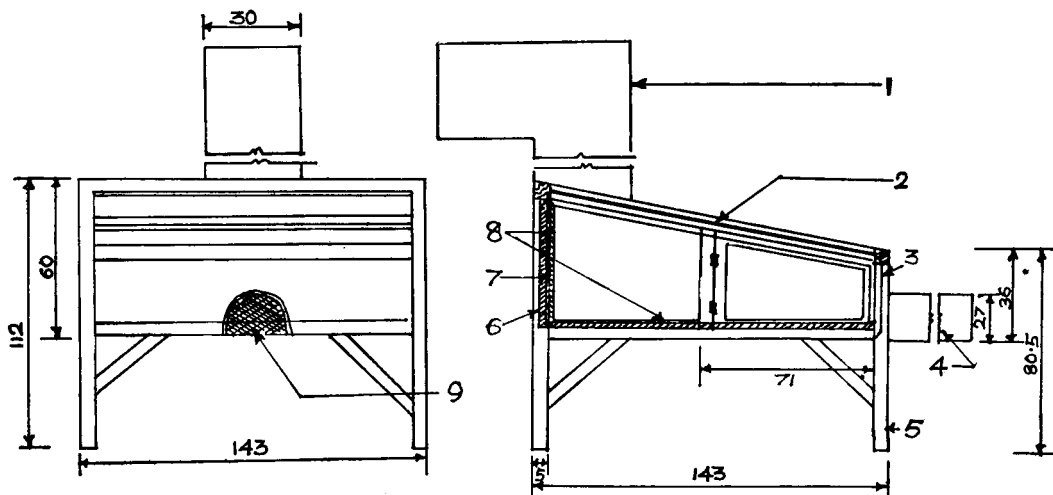
Copra drying efficiency of different drying surfaces and the solar cabinet drier developed at CPCRI Kasaragod is compared in this paper.

MATERIALS AND METHODS

Solar cabinet drier

A solar cabinet drier (Fig. 1) was developed at CPCRI, Kasaragod with 2 m² adsorbing surface of black painted GI sheet and solar radiation shield of 3 mm thick glass inclined at an angle

FIG. 1. SOLAR COPRA DRIER



- Parts: 1. Exhaust (G. I. Sheet) 2. Transparent cover (3 mm window glass) 3. Frame (Jack wood)
4. Inlet (G. I. Sheet) 5. Legs (Jack wood) 6. Wooden plank (Jack wood) 7. Insulation
(Coconut husk fibre) 8. Black painted G. I. Sheet 9. Wire mesh covering.

All dimensions are in cm.

equal to the latitude of the location *i. e.*, 12.50° ; inlet and exhaust ducts were also provided for air circulation.

Drying surfaces

Three surfaces *viz.*, black painted palmyra mat, jute cloth and cement floor were included in the study.

Open sundrying and solar cabinet drying experiments were conducted simultaneously.

Drying samples

Fully mature coconuts of West Coast Tall variety were split into two halves after husking. Water was drained off by keeping the cups inverted for a few minutes. On all the surfaces and in the cabinet drier, 70-80 cups/m² were spread in a single layer. The instantaneous average moisture content was determined by cutting small pieces of copra from randomly selected two to three-half nuts. These pieces were cut from the periphery to 1 cm depth. Moisture content of the composite sample was determined on oven dry basis by drying at 105°C for 5-6 hr. (Horvitz., 1975). First and last observations of the day were taken at 8.30 hr and 17.30 hr. On the first day of drying, four observations and for remaining period only three observations were taken. From 17.30 hr to 8.30 hr on the following day, drying samples were collected and kept in a wooden box.

Drying temperature and relative humidity

The temperature by mercury thermometer and relative humidity by Assman's psychrometer were measured for ambient air and inside the drier

at three locations (inlet, centre and exhaust).

Quality of copra

For each drying method, 25 cups were selected at random and tested for oil content and free fatty acid (FFA) content by AOAC method (Horvitz, 1975). The colour of copra and oil was judged visually.

RESULTS AND DISCUSSION

Initial moisture content of coconut meat was found to be 86% (dry basis). There was no appreciable change in the moisture contents at 17.30 hr and at 8.30 hr on the following day.

Drying temperature and relative humidity

Average day temperature for 10 days of drying period was in the range of $31.9 - 33.9^\circ\text{C}$. The average relative humidity was in the range of 71-79% and wind velocity 2.2-3.1 Km/h (Table II). Daily average temperature and relative humidity in the solar drier cabinet during drying is given in Table III. The trend in variation of temperature for second day of drying is given in Fig. 2. Increase in temperature was gradual upto 14 hr and decreased thereafter, since the sun goes down west after 14 hr, reducing fall of direct incident rays and the temperature. Even then, a minimum of $6-7^\circ$ difference was observed in ambient and in solar drier temperatures. Drier was kept facing south as per the recommended practice in northern hemisphere.

Drying and drying rate curves

The trend of change in average moisture content in the copra with drying

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Table II. Variation in ambient day temperature, RH, sunshine hours and wind velocity during the period of drying

Day of drying	Temperature °C	RH	Sunshine hr.	Wind velocity KMPH
1st	33.0	74.0	9.7	2.7
2nd	31.9	78.5	9.7	2.7
3rd	32.3	78.0	9.7	3.1
4th	32.7	71.0	9.8	2.6
5th	33.4	77.0	9.9	2.8
6th	33.8	72.5	6.5	2.2
7th	31.9	77.5	7.7	2.4
8th	32.4	75.0	8.2	2.4
9th	33.9	78.0	9.2	2.5
10th	33.3	79.0	9.6	2.8

Table III. Daily average temperature (of three points) and relative humidity in the solar cabinet drier

Day of drying	Temperature °C	Relative humidity (%)
1st	49.0	51.0
2nd	42.5	49.0
3rd	47.5	46.5
4th	48.0	34.0
5th	51.0	26.0
6th	44.0	42.5

time for all the methods is shown in Fig. 3. Drying rates (kg of water/kg of dry matter/hour) were calculated for all the surfaces and for solar drier, and graphs showing rate vs moisture content are given in Fig. 4. In all the methods, drying resulted in two distinct periods i.e., constant rate period (CRP) and Falling rate period (FRP). The FRP also showed change in the slope of the line which may be due

FIG. 2. VARIATION IN TEMPERATURE ON SECOND DAY OF DRYING

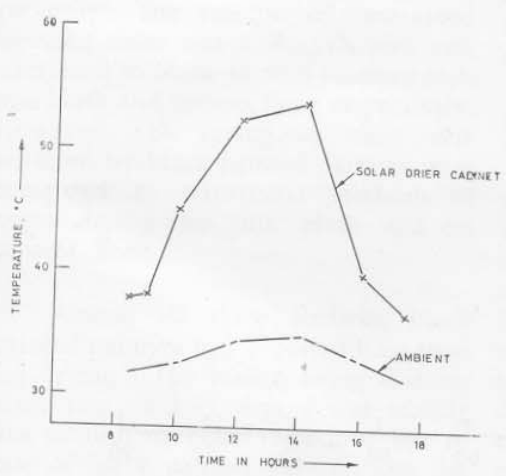


FIG. 3. DRYING CURVES FOR COPRA

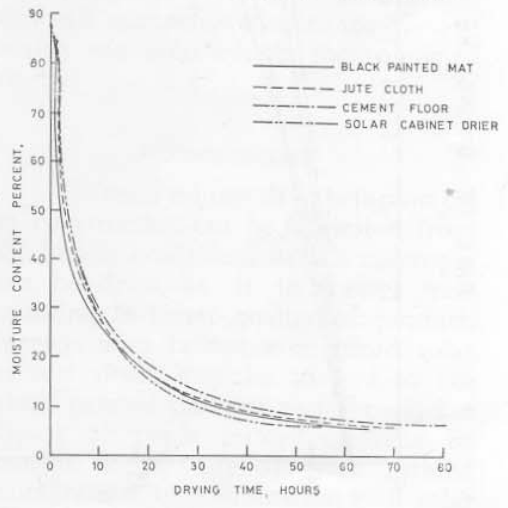
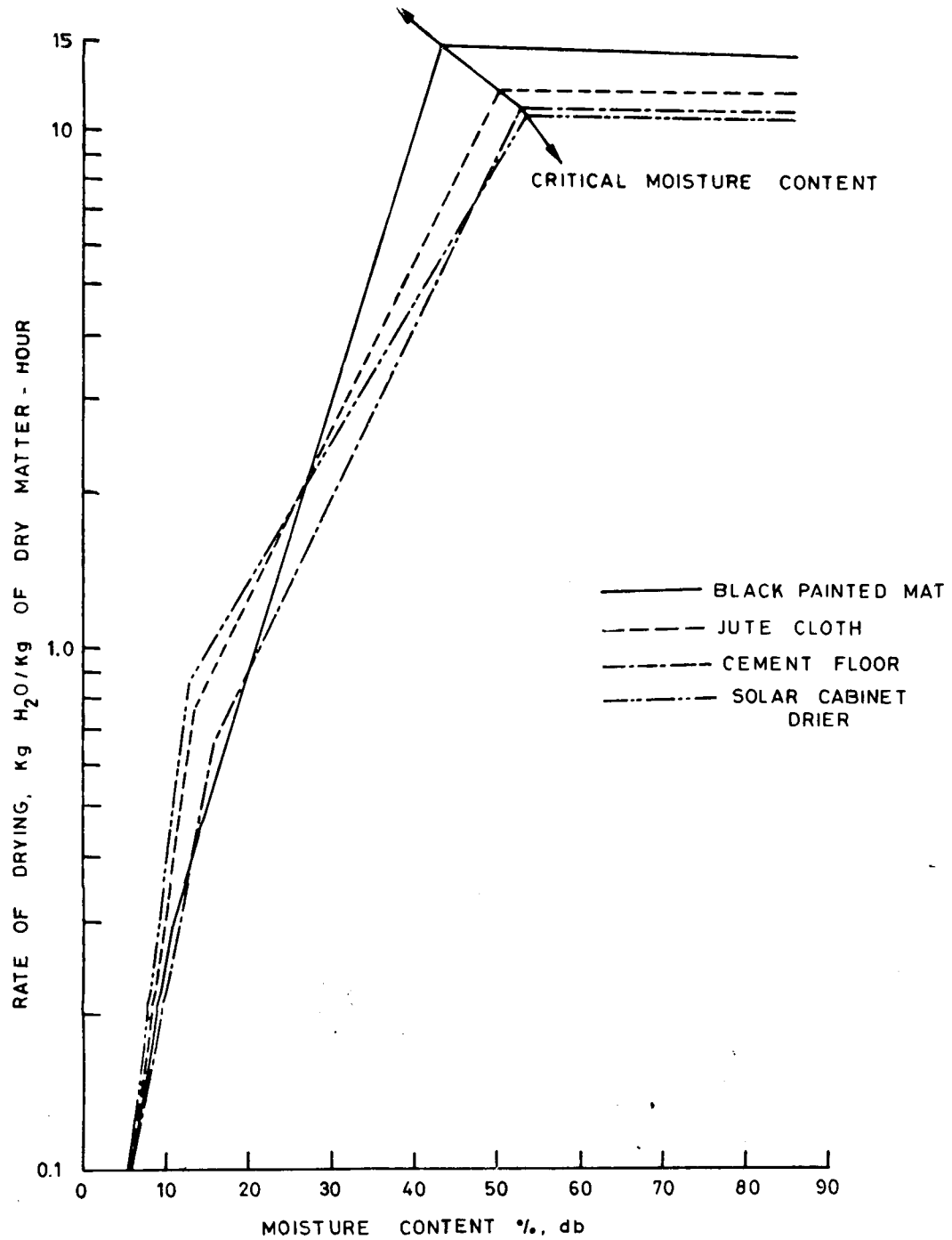


FIG. 4. RATE OF DRYING VS MOISTURE CONTENT OF COPRA DRIED ON DIFFERENT SURFACES AND IN SOLAR DRIER



to change in mechanism of moisture migration, from capillary to diffusion. The drying rate during CRP was more on black painted palmyra mat (0.1433 kg of water/kg of dry matter/hour) followed by jute cloth, cement floor and solar cabinet as 0.12, 0.11 and 0.108 kg of water/kg of drymatter/hour respectively. This may be due to the ample supply of fresh air in open drying as compared to that in the solar drier. The rate of drying was faster during FRP in the solar cabinet drier (0.003 kg of water/kg dry matter/hour; Table IV). This may be due to the higher temperature of air and low relative humidity in the drier at later period.

Drying time

The solar cabinet drier required about 50 sunshine hours (5.5 days) for moisture reduction of coconut kernel from 86% to 6%. The black painted palmyra mat, jute cloth and cement floor required 65 hr, 70 hr and 80 hr of drying (7 days, 8 days and 9 days) respectively. The amount of time saved by solar drier was 21%, 31% and 39% compared to black painted palmyra mat, jute cloth and cement floor respectively. However, 13% saving in time was achieved by black painted palmyra mat compared to traditional methods of copra drying on jute cloth and on cement floor.

Among all three surfaces, black painted palmyra mat required least time for drying. The reason being that on other two surfaces, drying was mainly due to heat of solar radiation; but in case of black painted palmyra mat, the

absorbed solar radiation might have created the effect of convective heat transfer, in addition to solar radiation. The qualities of drying surface responsible for quicker drying are high light absorption, high specific heat, and high resistance to conductive heat transfer and in all these features, the black painted palmyra mat was found more efficient than other two surfaces.

Quality of dried product

The oil content, free fatty acid content and colour of oil obtained from different treatments are given in Table V. There was no appreciable change in FFA content due to drying on different surfaces. The colour of both copra and oil obtained from samples dried in solar cabinet drier and black painted palmyra mat was better, (white copra and clear oil) and in other treatments copra was discoloured and oil obtained was turbid. Low oil content in the copra dried on jute cloth and cement floor may be due to the adhering dirt and extraneous matter, the effect of which was reflected on the colour of copra.

CONCLUSIONS

The solar cabinet drier being simple in construction can be fabricated from the locally available materials and copra can be dried in it in shorter time resulting in better quality of product. Farmers who cannot even afford solar cabinet drier, may be advised to use black painted palmyra mat for quicker drying of copra instead of mud or cement floors. Use of black painted palmyra mat in combination with solar

Table IV. *Drying rates during constant rate period (CRP) and falling rate period (FRP) for different drying surfaces and in solar cabinet drier (Kg H₂O/kg-dm/hr)*

Treatment	CRP	FRP
Solar drier	0.1083	0.0030
Black painted palmyra mat	0.1433	0.0017
Jute cloth	0.1200	0.0020
Cement floor	0.1100	0.0017

Table V. *Oil content, FFA and colour of copra*

Treatment	Oil content %	FFA (CC of 0.1N NaOH)	Colour of oil
Solar drier	70	0.10	Very clear
Black painted palmyra mat	69	0.11	Clear
Jute cloth	67	0.09	Coloured and turbid
Cement floor	68	0.10	Coloured and turbid

drier for copra drying is more economical because this combination drying reduces the drying time and also increases the operating capacity of the drier.

ACKNOWLEDGEMENTS

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REFERENCES

- ANONYMOUS 1978. *Agroclimatic Atlas of India*. Indian Meteorological Department, Poona. pp. 55-56.
- ANONYMOUS 1979. Central Plantation Crops Research Institute, Annual Report for 1977, Kasaragod, India. pp. 196.
- ANONYMOUS 1960. The Indian Central Coconut Committee, Annual Report, Ernakulam, India. pp. 88.
- CHILD, R. 1964. *Coconuts*, Longman, London. pp. 151.
- GIMMICK, G. R. 1964. *Coconut Palm Products*, FAO Rome. pp. 110.
- HORVITZ, W. 1975. *Official Methods of Analysis*, AOAC Washington DC. pp. 483.
- PATEL, J. S. 1938. *The coconut*, Government Press, Madras. pp. 313.
- THAMPAN, P. K. 1976. The coconut profile of India, (Mimeographed) Directorate of Coconut Development, Cochin. pp. 56.

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- CHILD, R. 1964. *Coconuts*. Longman, London. pp. 151.
- GIMMICK, G. R. 1964. *Coconut Palm Products*, FAO Rome. pp. 110.
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