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SOLAR CABINET DRYER FOR PERISHABLES AND CEREALS

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ABSTRACT

A solar cabinet dryer of $2m^2$ collector area was developed to dry perishables. The unit consisted of a rectangular insulated box with absorption plates covered with two layers of 3 mm thick transparent glass kept at a space of 25 mm. The solar cabinet dryer was intensively evaluated for drying copra, cassava and chillies. The temperature of air inside the cabinet dryer was observed as 84-86°C at 13-14 h when the ambient temperature was 34°C. The dryer took 8 h to dry Copra pieces of 40-60 mm size from 46 to 5 per cent moisture content. Cassava chips of 5-7 mm thick took 8 h to dry from 62 to 5 per cent moisture. Red chillies with moisture content of 68 per cent dried to 15 per cent in 5 h.

Similarly a cabinet dryer with solar energy collector having 36 m^2 area was developed to dry paddy and bajra. The payload of the dryer was 500 kg per batch. The maximum hot air temperature recorded in the cabinet dryer with energy collector was 55-56° C. Paddy at 23.5 per cent moisture content was dried to 11 per cent in 9 h in the cabinet dryer with energy collector, whereas bajra was dried from 23.2 to 11.8 per cent in the same time.

KEY WORDS : Cabinet dryer, Solar drying

There is an ever increasing demand to meet the growing energy needs of man. On the otherhand, there is rapid depletion of fossil fuel and the constant threat of pollution hazards due to excessive burning of fossil and nuclear fuel. These factors necessitate the search for newer sources of renewable clean energy sources. Solar energy has all the required attributes to provide a viable solution to this problem.

Renewed interest in solar energy was developed since 1973 as a result of increasing cost of conventional energy resources. India is endowed with annual average solar radiation intensity of 5-7 kWh m^{-2}. Solar energy is considered most appropriate to low temperature, instorage drying systems than high temperature high speed systems. The engineering design and analysis of solar processes present unique problems due to the intermittent and diffuse nature of the resources and the high initial cost. Singh and Alam (1985) rationalized the design of different components of a solar cabinet dryer and incorporated a wind aspirator and tested it for drying potato chips, spinach and mint. The solar energy can be effectively and economically made use of for agricultural applications like drying perishables and cereals. Kapoor and Agrawal (1975) dried peaches, peas and cauliflower in a solar cabinet drier in a temperature range of 66 - 77°C. The products dried in 2.5 to 18 h. Sarson Ka Sag (*Brassica compestris*) was dried in a cabinet drier from an initial moisture of 81.6 % to less than 10% in 17 h (Jarnail Singh *et al.*, 1989). To dry copra, red chillies and cassava a solar cabinet dryer of 2 m^2 collector area was developed. A solar cabinet dryer with energy collector having 36 m^2 area to dry 500 kg of paddy and bajra was also developed. The units were intensively evaluated to find out their drying efficiencies.

MATERIALS AND METHODS

A solar cabinet dryer of 2 m^2 (Fig. 1) was developed to dehydrate perishables. The unit consisted of a space for collecting solar energy and drying the products. It has a rectangular insulated box with absorption plates covered with two layers of 3 mm transparent glass kept at a space of 25 mm. Initial tests were conducted to study the heat transfer efficiency with no glass cover, one and two glass sheet covers over the absorber plate for the same air flow rate and absorber plate area. The variation in the hot air temperature showed that, double glass cover provided maximum hot air temperature (68°C) than other treatments (Mannan, 1975). Hence two layers of glass was adopted in the cabinet dryer.

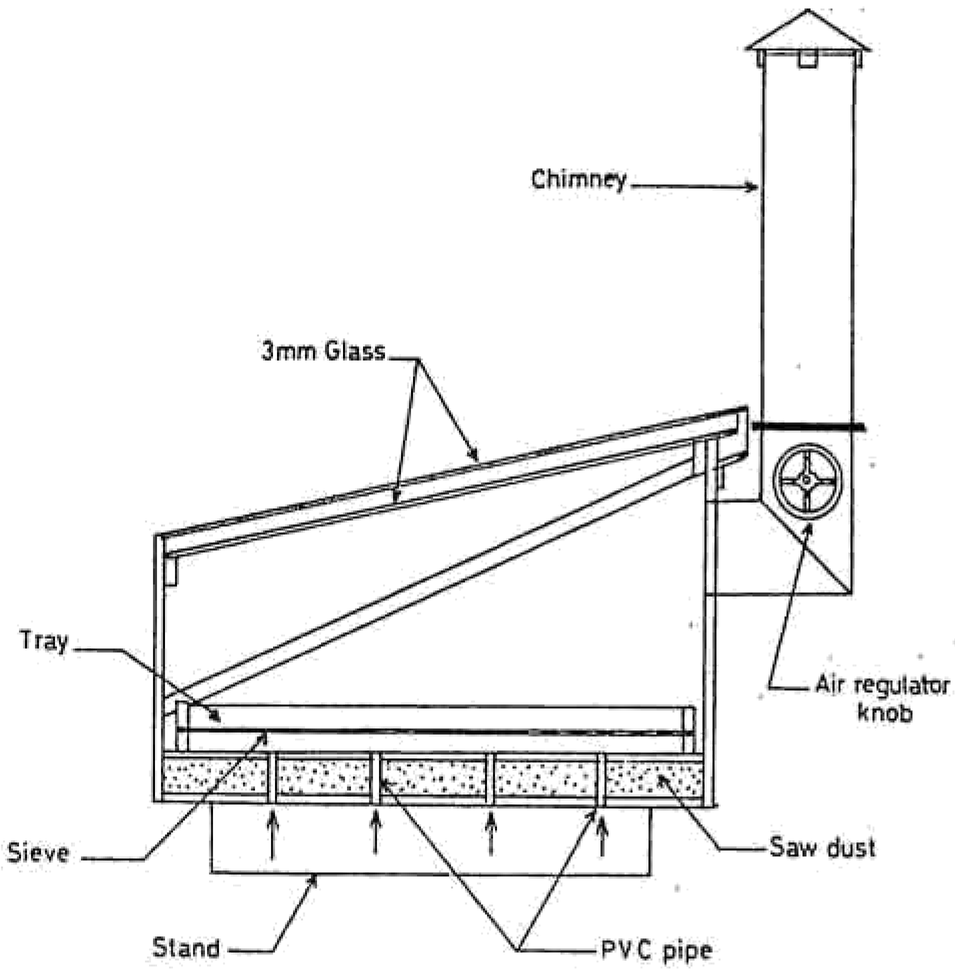

Fig. 1. Solar Cabinet Drier

The length of the cabinet was kept three times the width so as to minimise the effect of side panels. The angle of the roof cover was taken as 0.9 times the latitude of the place. The frame work of the unit was constructed using plywood. The bottom and side panels were insulated using saw dust to a thickness of 50 mm. The interior of the cabinet was painted black. Holes were provided at the bottom panels to allow ventilation to the evaporated moisture by natural convection. Aluminium perforated trays were used to keep the materials spread evenly and exposed to direct radiation from the sun. A chimney with butterfly value was attached to the unit to regulate the air flow rate, thus controlling the hot air temperature.

The solar cabinet dryer was intensively evaluated for drying copra, cassava and chillies. The tests were conducted in the month of April and May. The moisture content of the materials, atmospheric temperature, hot air temperature in cabinet dryer and relative humidity were measured every hour during each trial. Atmospheric temperature and temperature inside the solar cabinet dryer was observed using a dry bulb thermometer. Relative humidity was measured using a whirling phychrometer. The moisture content of the material was assessed with a help of a electric oven.

Drying of Copra

The cabinet dryer was used to dry 15 kg of copra. The copra was cut into pieces of 40 to 60 mm size. The initial moisture content of copra was observed. Simultaneously, test was conducted for drying one kg of copra in the open sun. The time taken for moisture removal to safe limit of 5% was found out.

Drying of Cassava.

Test was conducted to dry 15 kg of Cassava in the cabinet dryer. The cassava was made to chips of 5-7 mm thick. The initial moisture content of the

Table 1. Moisture reduction pattern in copra

Time (h)	Atmospheric conditions: Temperature (°C)	Relative humidity (%)	Solar intensity (mW cm^{-2})	Wind velocity (m s^{-1})	Hot air temperature (°C)	Moisture content (%)
9.00	28	58	58	2.3	56	46
10.00	30	52	68	2.3	68	40
11.00	32	50	79	2.1	72	34
12.00	34	48	86	2.0	86	29
13.00	34	42	84	1.9	84	24
14.00	33	41	82	2.2	81	18
15.00	32	40	78	2.1	76	16
16.00	30	49	72	2.2	74	10
17.00	30	52	63	2.3	68	5

chips was observed. Test was also conducted to dry 3 kg of cassava chips in open sun. The time taken for moisture removal to 5% was observed.

Drying of Red Chillies

Ten kilograms of red chillies was dried in cabinet dryer. The initial moisture content of the chillies was observed. The time taken to dry the product to 15% moisture content (w.b) was recorded. The viability of seed for germination was also tested.

Drying of paddy and bajra earheads

The cabinet dryer with solar energy collector having $36m^2$ was used to dry 500 kg each of paddy and bajra ear heads. The dryer consisted of air tight chamber fabricated one metre above the ground. The perforated tray is the bottom portion of the cabinet. The trays were arranged such that they could be drawn in and out to load and unload the grains. Mini doors were provided in the unit to take samples of the grain, when the dryer is in operation. The mini doors were also used to stir the bed of grains for effective drying. The grains were dried in a bed of 150 mm. The top of the cabinet was covered with a single layer of 3mm thick glass. In the top of the cabinet, four chimneys were fixed at equilateral distance to allow the exhaust air. At the downward side of the cabinet dryer, the collector was constructed. The collector was

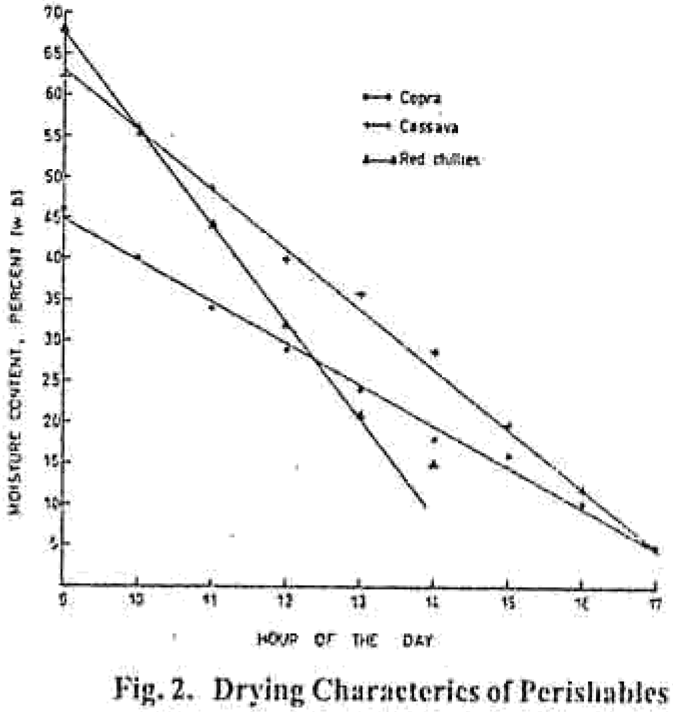

Fig. 2. Drying Characterics of Perishables

Table 2. Moisture reduction pattern in Casava chips

Time (h)	Atmospheric conditions Temperature (°C)	Relative humidity (%)	Solar intensity (mW cm^{-2})	Wind velocity (m s^{-1})	Hot air temperature (°C)	Moisture content (%)
9.00	29	58	64	2.1	68	62
10.00	31	55	68	2.0	71	56
11.00	33	53	80	2.0	74	49
12.00	33	53	82	1.8	82	40
13.00	34	50	85	1.6	83	36
14.00	33	48	79	2.0	86	29
15.00	32	52	76	2.1	82	20
16.00	31	55	70	2.0	74	12
17.00	30	57	66	2.2	62	5

inclined at an angle of 11 deg. The air entrance was covered with wire mesh to prevent the entry of rodents. etc. The sides of the collector were made air tight. The ground was covered with granite pebbles painted black for energy transfer. Since the cabinet was air tight, the hot air generated from the collector moved up due to thermal effect through the perforated trays and dried the grains. The initial moisture content of paddy and bajra was recorded. The grains were stirred once in 4 hours during drying.

RESULTS AND DISCUSSION

Drying of copra

The initial moisture content of Copra was observed as 46.0%. It was dried to 5% in the cabinet dryer. The atmospheric conditions and moisture reduction during the day are summarised in Table 1. From the table. it could be observed that the air temperature inside the cabinet reached 84-86°C between 13-14 h, when the ambient temperature was 34°C. The moisture content of the product gradually decreased from 46% to 5% in 8 h. The relative humidity was observed as minimum of 30-34% during 14 to 15 h. The wind velocity varied between 1.9-2.3 m s^{-1}. Peak solar radiation was observed as mW cm^{-2}. The time taken for the same moisture removal in open sun was observed as 16 h compared to 8 h in cabinet dryer. The drying characteristics curve is shown in figure 2.

Drying of Cassava

The moisture reduction. observed in the cassava chips along with the atmospheric conditions, is presented in Table 2. The initial moisture content of tapioca was observed as 62%. It was observed from the table that, cassava chips at 62% moisture content was dried to 5% moisture content in 8 h. The ambient temperature during

Table 3. Moisture reduction pattern in red chillies

Time (h)	Atmospheric conditions Temperature (°C)	Relative humidity (%)	Solar intensity (mW cm^{-2})	Wind velocity (m s^{-1})	Hot air temperature (°C)	Moisture content (%)
9.00	30	68	65	2.6	56	68
10.00	31	65	71	2.3	68	56
11.00	32	61	75	2.2	74	44
12.00	33	55	82	1.8	80	32
13 00	34	54	84	1.9	85	21
14.00	33	50	83	2.1	79	15

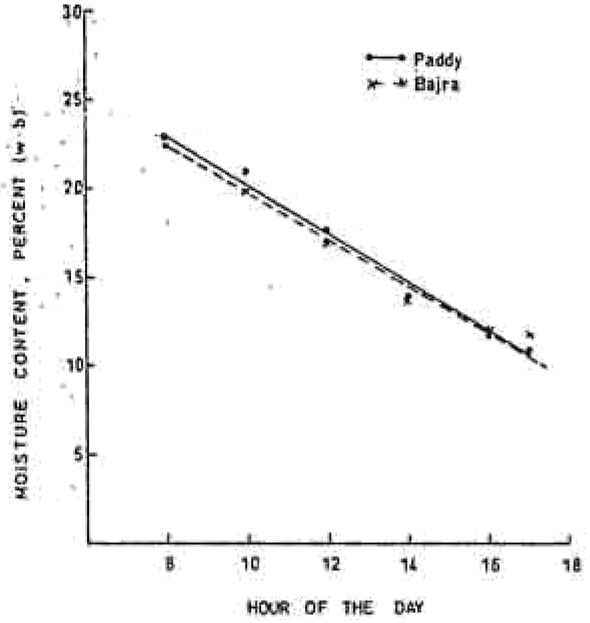

Fig. 3. Drying Characterics of Cereals

the period was 28-34°C with relative humidity of 40 to 58%. The maximum hot air temperature inside the dryer was observed as 86°C at 13.00 hours (Lawland, 1966). The time taken to dry the sample in open sun was 12 h.

Drying of Red Chillies.

The drying pattern of red chillies in cabinet dryer is shown in Table 3. The initial moisture content of the chillies was 68%. From the table it was observed that, red chillies was dried from 68 to 15% moisture content in 5 h. when the ambient temperature was 30-34°C, with relative humidity of 55-75%. The maximum hot air temperature observed in the cabinet dryer was 85°C. The time taken for the sample to dry in open sun was 17 h. The drying of chillies was quick in cabinet dryer. But the viability of the seeds was adversely affected due to high temperature drying. Hence the chillies dried in cabinet dryer was suitable for consumption only.

Drying of paddy

The drying pattern of paddy is presented in Table 4. The initial moisture content of paddy was recorded as 23.5% w.b. From the table, it was observed that paddy with 23.5% moisture content was dried to 11% in 9 h with bed thickness of 150 mm. The hot air temperature observed during the

Table 4. Moisture reduction pattern in paddy

	Atmospheric conditions					
Time (h)	Temperature (°C)	Relative humidity (%)	Solar intensity (mW cm⁻²)	Wind velocity (m s⁻¹)	Hot air temperature (°C)	Moisture content (%)
8.00	29.4	74	65	2.5	32	23.5
10.00	30.6	67	70	2.2	44	20.8
12.00	31.5	58	73	2.2	52	17.6
14.00	31.2	45	76	1.8	55	13.8
16.00	30.8	55	72	1.9	47	11.8
17.00	30.2	60	68	2.1	42	11.0

Table 5. Moisture reduction pattern in bajra earhead

	Atmospheric conditions					
Time (h)	Temperature (°C)	Relative humidity (%)	Solar intensity (mW cm⁻²)	Wind velocity (m s⁻¹)	Hot air temperature (°C)	Moisture content (%)
8.00	29.2	72	65	2.4	32	23.2
10.00	31.0	64	72	2.3	43	20.2
12.00	32.2	56	77	2.2	52	17.0
14.00	31.7	48	78	1.8	56	13.8
16.00	30.8	54	73	1.9	48	12.0
17.00	30.4	63	69	2.0	39	11.8

day was from 32-55°C. Maximum hot air temperature was recorded during 14.00 h. The drying characteristics curve is shown in figure 3.

Drying Bajra

The dehydration pattern of bajra earheads in solar cabinet drier with energy collector is shown in Table 5. From the table and drying characteristics curve figure 3, it was observed that bajra earheads with initial moisture content of 23.2% was dried to 11.8% in 9 h. The hot air temperature recorded during the day, varied from 32-56°C. Maximum hot air temperature of 56°C was observed at 14.00 h.

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EFFICACY OF VESICULAR ARBUSCULAR MYCORRHIZAL FUNGI ON THE MANAGEMENT OF ROOT ROT DISEASE OF *Casuarina equisetifolia* Forst

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ABSTRACT

Efficacy of four Vesicular Arbuscular Mycorrhizal (VAM) fungi on the management of root rot disease of *Casuarina equisetifolia* Frost caused by *Rhizoctonia bataticola* (Taub Butler) was evaluated. All the four VAM fungi when applied to soil significantly reduced the root rot incidence in the nursery. VAM fungi treated plants showed significant increase in dry weight when compared to pathogen inoculated plants. Among the VAM fungi *Glomus fasiculatum* recorded the least disease incidence with maximum dry weight.

KEY WORDS : *Casuarina equisetifolia*, VAM, Root rot disease, Management

INTRODUCTION

Root rot disease caused by *Rhizoctonia bataticola* is the most serious soil borne disease in the nurseries of forest trees. The pathogen is known to attack more than 500 species of plant. Drenching the plants with chemical fungicides is prohibited because of the problem of residual toxicity, acquired resistance and high cost of chemical application. Seedling root rot in *Casuarina* is known to cause serious damage and have been reported from Karnataka and Maharashtra states in India (Qurshi, 1956). Mycorrhizal fungi are known to reduce the incidence of disease (Zak, 1964). In green house studies VAM fungi reduced the effects of several pathogens on their hosts. The disease caused by *Thielaviopis basicola* on tobbaco and alfalfa, *Fusarium oxysfporum* f. sp. *lycopersici* on tomato, *Phytophthora megaspora* var. *sojae* on soybean and *Pyrenochaeta terrestris* on onion and *Rhizocotonia solani* and *Pythium ultimum* on poinsettia were reduced by different species of VAM fungi (Schenck and Kellam, 1978). Hence with a view to investigate the effect of VAM fungi on the management of diseases in *Casuarina* seedlings in the nursery, studies were conducted at the Forest College and Research Institute, Mettupalayam - 641 301, Tamil Nadu, India and the results are discussed hereunder.