DESIGN AND DEVELOPMENT OF SMALL DRIER FOR COCOA BEANS

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ABSTRACT

A tray type, through-flow drier was designed and developed for drying upto 40 kg of fermented cocoa beans. The drier can be operated on electricity (single phase), biogas burner or kerosene wick stove. During the rainy season 40 kg fermented beans were dried from an initial moisture content of 115% (db) to 8% (db) in 60 hours. The drier gave a heat utilisation efficiency of 53% when operated on electricity. The cost of the drier worked out to Rs. 1000/- and drying cost Rs. 0.50 per kg of dry beans.

INTRODUCTION

In India, the peak harvesting period of cocoa coincides with the monsoon months. Hence there is need for artificial drying of beans to prevent infestation with fungus. Moreover, due to lack of technical know-how on fermentation and nonavailability of a suitable cocoa drier the growers sell the wet beans to the nearest cocoa collection centres operated by private firms.

Several workers (De Vos, 1956; Shelton, 1967; Bravo and Mc Caw, 1974; wood, 1957; Howat, Powel and Wood, 1957 and Salz, 1979) reported the results of various drying temperature, duration, air flow and efficiency of the drying units for cocoa beans. In general, drying at 60°C (bean temperature) for drying period of 24 hr or more was found to be suitable for cocoa.

MATERIALS AND METHODS

A drier was designed to handle 40 kg of fermented beans (Fig. 1A and 1B) considering the following factors.

In India, the peak harvesting season of cocoa is during months of June to August. On an average a cocoa tree yields 30–40 pods per year and during the peak season the tree may give 3–4 pods in single harvest. Thus a grower having about 300 cocoa trees will get 900–1200 pods. During this season harvest is generally done once in every week. Since the pods can be stored for 2–3 days, about 600 pods only can be opened at one time and remaining pods after a gap of two days. This will help in handling the beans in a small capacity drier. About 600 pods will give about 50 kg wet beans which on fermentation will be about 40 kg. Therefore a drier has been developed to handle upto 40 kg fermented beans.

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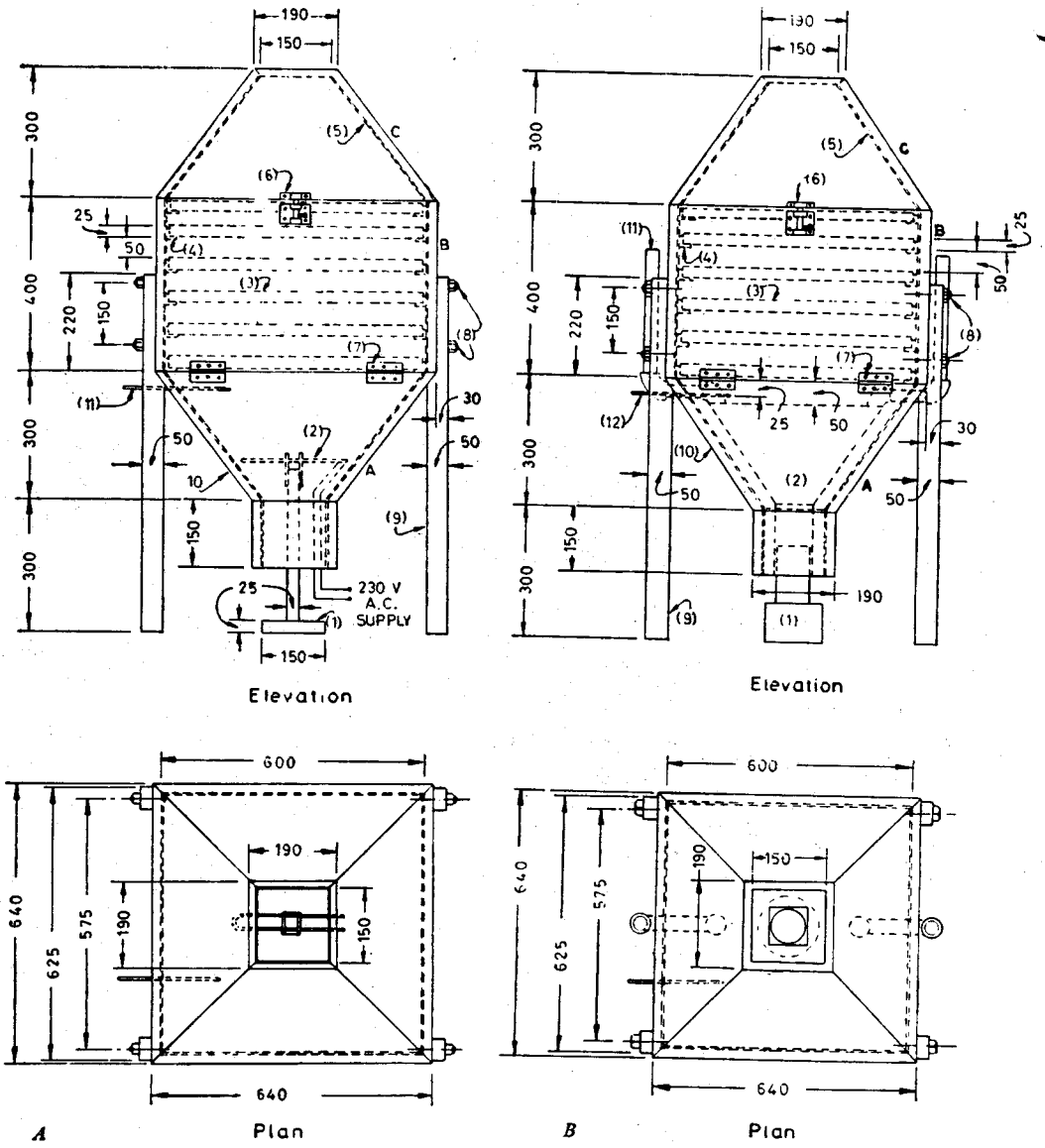
FIG. 1A & B. COCOA BEANS DRIER



(Scale 1:10—All dimensions are in mm)

Fig. 1A. A. Plenum chamber B. Drying chamber C. Exhaust air chamber

1. Heater stand 2. Heater (500W) 3. Perforated Al. trays (600×560×25) 4. Al. angle (25×25) 5. G. I. Lining sheet 26 gauge 6. Tower bolt 75 mm 7. Hinge 75 mm 8. 10×90 Bolt with nuts 9. 50×50 Wooden legs 10. 20 Thick benteak/jackwood chamber 11. Thermometer.

Fig. 1B. A. Plenum chamber B. Drying chamber C. Exhaust air chamber

1. Heat source (Wick stove/gas burner) 2. Heat exchanger 3. Perforated Al. trays (600×560×25) 4. Al. angle 25×25 5. G. I. Sheet lining 26 gauge 6. Tower bolt 75 mm 7. Hinge 75 mm 8. 10×90 Bolts with nuts 9. 50×50 Wooden leg 10. 20 Thick benteak/jackwood chamber 11. Smoke outlet (G. I. Pipe 33 mm) 12. Thermometer.

The drier is of tray type and designed without a blower. As the quantity of beans to be dried is small and drying air temperature permissible upto 70°C the need for providing a blower was not felt to be necessary. The heat exchange unit was provided so that either biogas burner or kerosene wick stove can be used as source of heat.

Since it is known that cocoa beans mucilage causes quick corrosion of iron based materials, perforated aluminium sheet trays were made to handle the beans for drying. The lining inside the drying chamber is of 26 gauge GI sheet. The chamber and frame are made of hard wood with a view to serve two purposes (1) sturdiness of the drier and (2) complete insulation of heat.

EXPERIMENTAL PROCEDURE

The drier was tested for two loads, *viz.*, 30 kg and 40 kg fermented beans. In preliminary test trial carried out for a load of 30 kg fermented beans with a 750W heater, it was noticed that the temperature of drying air rose as high as 90°C, though the drying time was only 35 hours. Therefore, only 500W heater was fixed so that drying air temperature could be maintained below 75°C.

In each of the 30 kg and 40 kg fermented bean load trials each tray was loaded with 5.00 and 6.60 kg beans respectively. A sample of 100 gm beans was taken initially from the lot to determine moisture content by oven dry method. In each trial the temperature of drying air and outgoing air were recorded. Other parameters like room temperature (dry bulb and wet bulb) were also recorded. In the case of kerosene wick stove, the temperature of drying air was regulated by adjusting the flame.

After every 8 hr interval the heater was put off for 15 minutes. The beans were raked by hand and tray position changed as shown in Table I. The completion of drying was first judged by visual observation and by pressing the bean between palm and fingers. After drying, the moisture content of beans was also determined. Final weight after drying and pH of the dried beans were determined (Table II).

Table I. *Schedule of changing tray position at different intervals of time after starting the drier*

At start	8 hr.	16 hr.	24 hr.	32 hr.	40 hr.	48 hr.
1*	6	1	2	3	4	5
2	5	6	1	2	3	4
3	4	5	6	1	2	3
4	3	4	5	6	1	2
5	2	3	4	5	6	1
6	1	2	3	4	5	6

*** Numerals indicate the tray numbers and its position vertically in the drier**

Table II. *Observations on testing of the drier*

Weight of beans loaded in the drier, (kg)	Initial moisture content of beans % (d b)	Source of heat	Room air conditions temp (db) °C, R. H%	Exhaust air condition at 24th hr. after start-temp. (db) °C, R. H%	Time taken to dry the beans (hours)	Final moisture content of dry beans % (db)	Weight of dried beans, (kg)	Labour required for drying operation (man hr.)	Electricity or kerosene consumed, KWh or litre	Heat utilisation efficiency of drier, (%)	pH of dried beans
30	115	Electric heater	27.3, 82	45, 91	48	7.0	13.93	1.5	20.0 KWh	56.0	5.3
30	112	"	27.1, 83	44, 92	46	7.2	14.88	1.5	19.5 KWh	54.0	5.2
40	106	"	25.2, 90	41, 91	60	7.0	20.46	1.5	26.0 KWh	52.5	6.1
40	109	"	26.0, 87	43, 92	64	6.9	20.22	1.5	28.0 KWh	49.5	6.2
30	106	Kerosene wick stove	26.0, 86	43, 91	48	6.8	15.36	2.0	5.00 lit.	–	5.2
30	110	"	26.0, 86	41, 89	48	7.2	15.06	2.0	5.00 lit.	–	5.3
40	108	"	26.5, 85	43, 94	60	7.5	20.28	2.0	6.05 lit.	–	5.9
40	116	"	25.7, 89	42, 92	62	7.4	19.56	2.0	6.25 lit.	–	6.0

RESULTS AND DISCUSSION

Observations on testing of the drier are presented in Table II. During the testing period the temperature of the room varied from 25.2°C to 27 3°C and the exhaust air temperature at the outlet of the drier was between 41°–45°C at 24th hour of continuous drying. The relative humidity of outgoing air varied from 91 to 94 per cent in the experimental lots where 40 kg beans were dried and that from 89 to 92 per cent when 30 kg beans were dried. The difference in humidity between the two lots may be due to the fact that in 24 hr 30 kg beans shall be dried more, than 40 kg.

With electric heater, on an average 30 Kg beans were dried in 47 hours and 40 Kg in 62 hours. Similarly with kerosene wick stove 30 Kg beans were dried in 48 hr and 40 Kg in 61 hr. In all the experimental trials moisture content of fermented beans was in the range of 106–115 per cent (db) and that of dry beans varied from 6.80 to 7.5 per cent (db).

The temperature of drying air was controlled by the heating, capacity of the heater and adjusting the wick flame of the stove, as the case may be. Temperature inside the drier can be partially regulated by partial closure of the air outlet by a piece of metal sheet.

The pH of a sample of beans collected randomly from each of the dried lots was determined. On an average the pH was 5.25 in case of beans dried in 30 Kg lots and 6.05 in 40 Kg lots. This indicates that the beans dried in

ts of 40 kg are better than those dried n 30 Kg lots. However, none of the dried lots had an unacceptable value of pH. The beans were also free from fungus attack.

The cost of drier worked out to Rs. 1000/- and drying cost at Rs. 0.50 per Kg of dry beans with electric heater as well as kerosene wick stove. The drier can also be used on biogas burner.

ACKNOWLEDGEMENTS

The author wishes to thank Mr. E.V. Nelliat, Head, Division of Agronomy and Dr. N.M. Nayar, Director, CPCRI for constant encouragement and valuable suggestions.

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