

## Drying characteristics of cardamom in fluidised bed drier

B. BALAKRISHNAN AND V.V. SREENARAYANAN

College of Agricultural Engineering, Tamil Nadu Agril. University, Coimbatore-641 003, Tamil Nadu.

**Abstract :** A batch type fluidised bed drier of smaller capacity was developed for drying cardamom. Experiments were conducted to determine the drying characteristics of cardamom with three heated air temperatures viz. 40, 50 and 60°C and three air velocities viz. 35, 40 and 45 m/s. The results of the study showed that better quality dried product could be obtained from cardamom capsules. The drying of cardamom capsules was followed in falling rate period and drying behaviour found was exponential in nature. The drying time varied between 7.5 and 12.5 h for all the treatments. The drying rate of cardamom was higher during initial stages with all the combinations of air velocities and heated air temperatures and decreased as equilibrium moisture content of cardamom capsules approached. The quality of the dried product was found to be very good at an air velocity of 40 m/s at a drying temperature of 50°C, whereas product from all other treatments were found good.

**Key words:** Fluidised bed drier, Air temperature, Air velocity, Drying rate.

### Introduction

Cardamom (*Elettaria cardamomum* L.) is the most versatile spice known to the mankind. India used to export 85 per cent of its output of cardamom in 1980's but now its exports are down to 3 per cent of the domestic production. Ten years ago India exported 3,500 tonnes out of the 4,000 tonnes cardamom produced in the country (George, 1997). Now our exports are hardly 250 tonnes out of 7,000 tonnes being produced in the country due to severe competition offered by Guatemala in the global market (Vikas singhal, 1999).

Cardamom capsules are processed in two ways namely green cardamom and bleached cardamom. Both the process involve the operation of drying the capsules to a safe storage moisture content of 11 % (d.b.) . Drying is the most important unit operation as it determines the colour of the end product, which is the attractive and most important quality character. The aim of drying of cardamom is to prevent undesirable changes in the wholesomeness, colour, flavour and essential content. Drying is a comparatively cheaper method over other methods of preservation.

The present investigation was aimed at drying cardamom using a fluidized bed drier. Studies conducted at Regional Research laboratory on the fluidized bed drying of pepper gave positive results. Experiments were conducted with fresh

green cardamom capsules to evaluate its performance when dried in fluidized bed drier and it is reported here.

Fluidisation is a technique wherein granular solid particles were contacted with air at relatively high velocity. In fluidisation, air velocity was always maintained at such a level that the particles do not fly off with the air stream. When hot air was used for fluidisation, the wet solid particles get dried. Such a system is called fluidized bed drying. When the solid particles suspend in the flowing air stream, contact area between the phases are large, results in the intense mixing of solids and enhances the drying rate appreciably resulting in faster drying (Thomas *et al.* 1991).

### Materials and Methods

A small-scale pilot level batch type fluidized bed drier was developed which consisted of a blower, heating chamber, mainframe and drying chamber. A blower with a capacity of 135 m<sup>3</sup>/min was used. The suction side of the blower was provided with sliding gate to adjust the air discharge. The heater assembly was made in cylindrical shape, with three numbers of heating coils, each 1 kW capacity connected in series. A thermostat was provided to control the temperature of hot air. A bin was provided to hold the cardamom capsules, which can be removed at periodical intervals for weighing the cardamom along with the bin to avoid spilling of cardamom while handling.

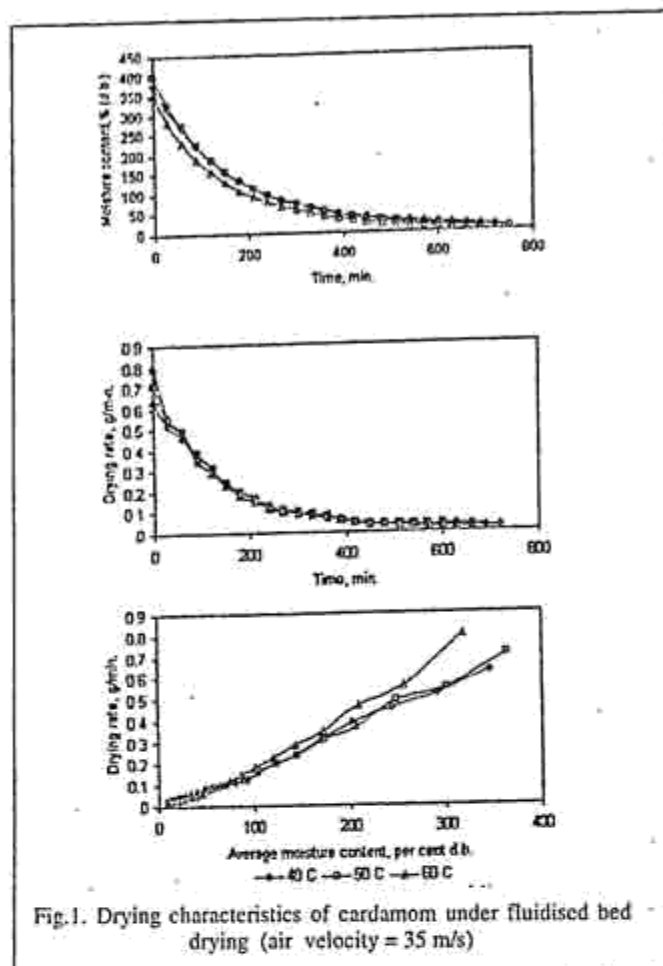


Fig.1. Drying characteristics of cardamom under fluidised bed drying (air velocity = 35 m/s)

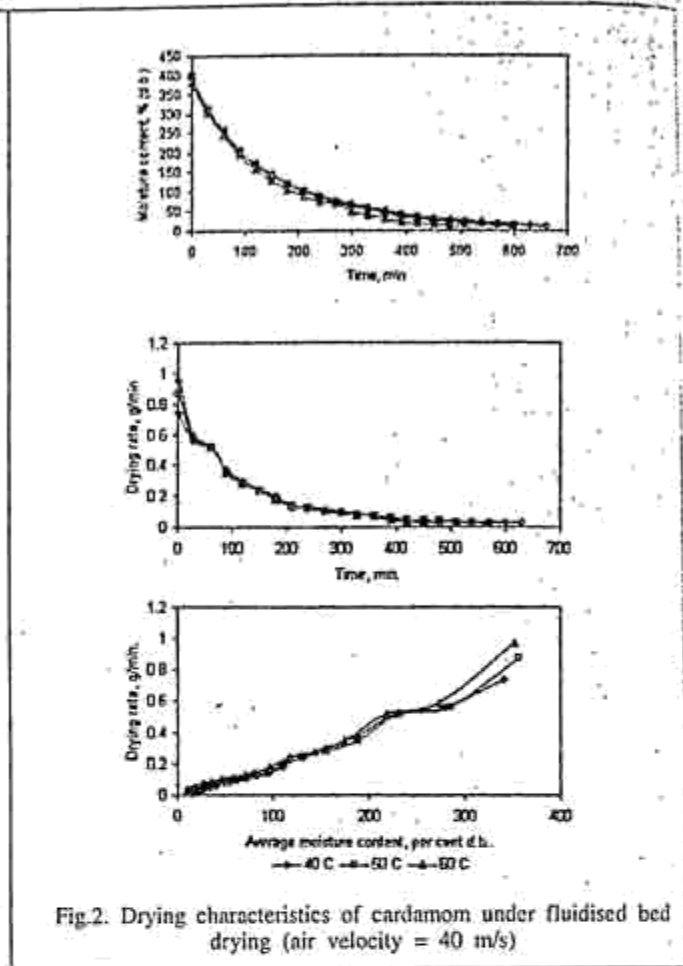


Fig.2. Drying characteristics of cardamom under fluidised bed drying (air velocity = 40 m/s)

Fresh harvested green cardamom was used in the experiments within 24 hours of harvest. The cardamom capsules were washed thoroughly in running water to remove adhering extraneous matter and were spread on a table top to remove the surface water. Immature and pest affected cardamom capsules were removed. In each experiment 150 g of the cardamom sample was used. The initial moisture content was determined by toluene distillation method using Dean and Stark apparatus.

The blower was switched on followed by the heater. The air velocity was adjusted by the sliding gate and it was measured using an anemometer. The drying air temperature was adjusted to the set value and controlled by using a thermostat. Once the set value was attained, weighed quantity of cardamom capsules were introduced into the fluidisation column. The weight of the sample was taken at periodical intervals by weighing the cardamom along with the bin to avoid spilling. The fluidized bed drying experiments were carried out at temperatures of 40, 50 and 60°C at different air velocities *viz.* 35, 40 and 45 m/s.

Organoleptic evaluation of the dried product was done by a panel of 7 trained judges for colour, flavour, texture, taste and overall acceptability by using 9 point scale described by Watts *et al.* (1989).

### Results and Discussion

The drying characteristics of cardamom under fluidized bed drying are illustrated in figures 1, 2 and 3.

#### (i) Effect of air velocity on drying time

The air velocity was optimized based on the experiments conducted.

The curves for air velocities of 35 and 40 m/s were virtually identical and only the curve for the higher velocity was significantly different. The time taken for drying at 40, 50 and 60°C at an air velocity of 35 m/s were 750, 690 and 630 min respectively. Similarly the time taken for drying at same temperatures at an air velocity of 40 m/s were 660, 600 and 510 min respectively. But for the same reduction of moisture content, the time taken for drying at an air velocity of 45 m/sec at

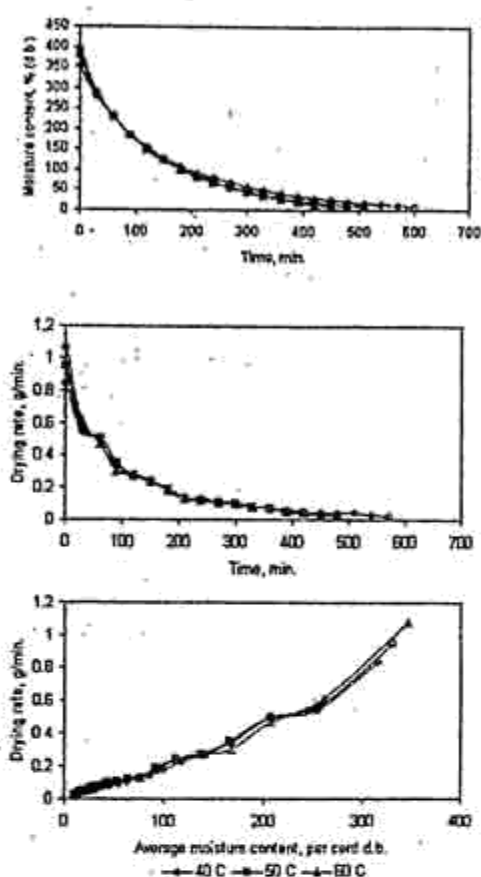


Fig.3. Drying characteristics of cardamom under fluidised bed drying (air velocity = 45 m/s)

40, 50 and 60°C were 600, 510 and 450 min respectively. It was observed that effective fluidization and required quality of dried cardamom were achieved at an air velocity of 40 m/s at 50°C. Drying at an air velocity of 35 m/s took relatively longer time than drying at other velocities. It was evident that an increase in the air velocity increased the drying rate. It was also observed that the percentage of split and discolored capsules were found to increase in case of higher temperatures and airflow rates. But the cardamom dried at an air velocity of 40 m/s at 50°C was found better in terms of colour and flavour.

#### (ii) Effect of temperature on drying rate

Figures 1, 2 and 3 represent the effect of temperature on drying rate of cardamom under fluidized bed drying. It was evident that an increase in the drying air temperature increased the drying rate and it decreased as the moisture content

of the product fell below the critical point. Drying at temperature of 40°C showed relatively lesser drying rates in all air velocities. There was only little difference in drying rate between temperatures of 50 and 60°C. The cardamom dried at temperature of 50°C was found better in terms of colour. It was also noted that temperatures higher than 50°C in the drying process were found to affect colour.

#### (iii) Optimization of the Drying Process

In fluidized bed drying cardamom dried at 50°C at an air velocity of 40 m/s was found to be optimum to get a good quality product. The green colour of the cardamom was faded in case of samples dried at an air velocity of 45 m/s. The organoleptic qualities of the end product dried in fluidized bed drying was found to be acceptable in all responses like colour, flavour, and texture.

From the study, the following conclusions can be drawn.

- (i) Fluidized bed drying took nearly 12.5 to 7.5 h to dry cardamom with an air velocity of 10-14 m/s at different air temperatures.
- (ii) Temperature of drying air had profound effect on drying rate of cardamom capsules. Higher the drying air temperature, higher was the drying rate in fluidized bed drying.
- (iii) Drying for 10 h at an air velocity of 12 m/sec at a drying air temperature of 50°C was found to be optimum in fluidized bed drying.

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