Development of Efficient Drying Process for Cocoa Beans

M. Nordin Ibrahim

Faculty of Engineering
Universiti Putra Malaysia
43400 UPM, Serdang, Selangor
Malaysia

E-mail of Corresponding Author: nordin@eng.upm.edu.my

Key words: drying process, cocoa bean.

Introduction

Drying of cocoa beans is not simply a matter of removing moisture from the bean since chemical changes occurring inside the bean could be affected by lack of moisture or inactivation of the enzymes by some other means. Knowledge of the characteristics of cocoa beans and changes occurring during dehydration process will be useful in cocoa beans drying task, so that necessary treatments could be identified and employed to ensure successful processing operation as well as obtain good quality products.

Design of a drying system requires information concerning airflow resistance of the materials in order to appropriately determine the fan for supplying the air through the system. The resistance of the material to airflow is determined in terms of pressure drop across the bed of material, which depends on airflow rate, bed depth, compaction, moisture content, surface and shape characteristics of the material. Cocoa beans have been found to be very hygroscopic; the moisture content, which is attained by a product in a given relative humidity and temperature environment, is known as the equilibrium moisture content (EMC) for that environment. For drying, EMC information is useful in determining the appropriate drying air conditions, specifically temperature and relative humidity; while for storage, it is useful to predetermine the appropriate storage conditions suitable for safe storage of the beans.

The drying rate, of biological product normally comprises of two stages, The constant-rate period occurs at the beginning of the drying operation when the moisture content of the material is higher, and solely for the removal of surface moisture. Falling-rate drying occurs at later stage of drying involving the internal moisture migration from the center to the surface of the material. Cocoa beans undergo both drying rate stages due to the high moisture content after fermentation process it has been recommended (Salz, 1972) that these drying-rates stages should be appropriately utilized in the drying of cocoa beans i.e. constant-rate drying of surface moisture and falling-rate drying due to moisture migration from the center to the surface of the bean.

The major drying parameters pertinent to a batch drying method are the relative humidity and temperature of the drying air, its flow rate and the material bed depth (Brooker et al., 1974). It is desirable to employ a high air temperature to ensure rapid removal of water. Cocoa beans are usually damaged by heat if they are xposed to high temperatures for long period, especially at moisture contents of less than 20%. Besides relative humidity and temperature of the drying air, its flow rate is also an important factor in a successful drying process. A reasonable airflow rate has to be established since it determines the drying rate and the corresponding drying time.

In order to analyse drying process and design as well as simulate drying system for cocoa beans, it is useful and important to have sufficient and accurate information on physical as well as thermal properties of cocoa beans. Very limited information on these properties is available. Properties such as resistance to air flow, specific heat, thermal conductivity, heat of vaporization, EMC, and drying rate which directly affect drying process are yet unavailable.

Materials and Methods

EMC Determination

EMC determination was carried out by storing cocoa bean samples at several combination of temperature and humidity's The various values of relative humidity were obtained by using salt solutions. The equilibrium moisture contents achieved for each combination of temperature and humidity were then determined.

Resistance of cocoa bean to airflow determination

The pressure drops for certain thickness of cocoa beans at various air flow rates were determined. These pressure drops reflect the resistance of the cocoa beans to air flow.

Drying rate determination

Thin layer drying experiments are to be conducted to determine the removal of moisture from cocoa beans under several values of drying parameters.

Results and Discussion

Description curves for local cocoa beans at 30°C and 60°C at certain relative humidity has been obtained. At 30 °C which is about the average local ambient temperature, the local wet cocoa beans would approach moisture content of less than 10% within 10 to 15 days provided the relative humidity's are 76% and below. If exposed to air at 60 °C, the moisture content would drop to less than 10% within one week even at normal average ambient relative humidity of 82-83%.

Cumulative pressure drop at four levels of bed depth for several air velocities have been obtained. The cumulative pressure drop increases with velocity at any bed depth, and the cumulative pressure drop increases with bed depth particularly at higher range of velocities. There is a strong relationship between air velocity and pressure drop per unit bed depth (Pa/m), whereby it indicates that the resistance of cocoa beans to airflow is higher at higher air velocities.

Conclusions

Some data on desorption curves for cocoa beans as well as resistance of cocoa beans to airflow have been obtained, which can be used for designing and operation of drying system for cocoa bean drying.

Benefits from the study

The study provided a better understanding and development of appropriate drying process for cocoa beans.

Literature cited in the text

None.

Project Publications in Refereed Journals

None.

Project Publications in Conference Proceedings

None.

Graduate Research

None.

I·R·P·A INTENSIFICATION OF RESEARCH IN PRIORITY AREAS

Research funded by the Intensification of Research in Priority areas (IRPA) - Supported by IRPA RM-7 (1996-2000), Cycle 1996, Grant 01-02-04-0133.