Optimum Drying Operation for Cocoa Beans

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Introduction

Drying of cocoa beans after fermentation is an essential post harvest operation to ensure that the beans are dry for safe storage or suitable for subsequent processing. Drying of cocoa beans is not a simple 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 (Rohan et al., 1963). The pH changes during drying process with considerable reduction in activity at 5.0. Artificial drying normally results in a relatively low, final pH and sometimes too low causing incomplete oxidation (Howat et al, 1957). 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. A lower relative humidity provides a better drying potential causing more water to evaporate from the material. Increasing the temperature of the drying air by heating causes a reduction in its relative humidity, also results in corresponding increase in material temperature, which causes increase in vapor pressure differential, thus improving the drying potential (Brooker et al., 1974; Hall et al., 1980). While it is desirable to employ a high air temperature in cocoa bean drying to ensure rapid removal of water, it must not be too high such that it might lead to inactivation of enzyme system responsible for the chemical reactions for good chocolate flavor development (Rohan et al., 1963). Cocoa beans are usually damaged by heat it they are exposed to high temperature for long period, especially at moisture contents of less than 20%. Bean of good quality have been produced by employing drying air temperature of as high as 80°C with a drying time of as short as 14 hours (Howat, et al, 1957). However, the temperature of the bean should not exceed 60°C as otherwise change to flavor and color of the nib would occur (Rohan et al., 1963). If acidity is a problem, lower temperature, consequently longer drying time, improves quality (Hubbard et al., 1976). Drying operation carried out by using Barico dryer employing the three-day cycle method resulted in the production of cocoa beans with an average pH of 5.2 which is better than usual (Anselmi et al., 1976). This is attributable to the low temperature drying (40°C – 50°C) during the first twenty-four hours on the skin-drying platform, which allows the continuation of the enzymic conversion of acetic acid to carbon dioxide and water.

Materials and Methods

This study was conducted to determine the best drying conditions for drying of local cocoa beans. Experiments were conducted for several drying air temperatures and air flow rates under two drying operations strategies: continuous drying operation and two stage drying operation; continuous drying operations were carried out at set conditions of temperature and air flow rate until the cocoa beans were considered dry; Whereas, the two stage drying was comprised of initial drying stage at one set of drying air temperature and flowrate, and final drying stage at another set of air temperature and flow rate. The following operating parameters were used for the two drying strategies: for continuous drying strategy, the drying air temperature were 60°C, 65°C, 70°C, and the air flow rates were 0.5, 1.5, and 3 m/s; for the two stage drying, the same temperature range were used with a combination such that a higher temperature value was used for the final drying stage than the initial stage, and the airflow rates were 1.5 and 3 m/s. Two to three layers of cocoa beans were used for each drying run using an experimental dryer set-up in the laboratory. For quality evaluation after the drying runs, dried cocoa bean samples were subjected to acidity test and cut test.

Results and Discussion

It was observed that the drying rates generally increased with higher drying air temperatures and higher air flow rates. These observations were true for both the continuous drying strategy as well as for the two stage drying strategy. For cocoa beans, achieving higher drying rates should not be at the expense of quality. As such the optimum drying conditions should be based on the bean quality corresponding to the drying rate. Table 1 and Table 2 showed the quality (ph and cut test) of dried cocoa beans for continuous drying and the two stages drying respectively. It could be seen that the quality obtained for 60°C and 65°C drying air temperatures at all airflow rates are better than that obtained at higher temperature of 70°C. This is because the ph obtained is less than 5, which is becoming more acidic at 70°C and the % good bean based on cut test is lower than 90%. For the two stage drying, even though the ph is acceptable for all tests, the % good bean is less than 90% at higher temperature of 70°C. The moderate temperature of 65°C used in the final drying stage resulted in better quality-dried cocoa beans.

Conclusions

For continuous drying strategy, constant drying air temperature of 65°C produced better quality dried beans with reasonable drying rate. For two stage drying, a temperature of 60°C in the initial drying and 65°C in the final drying stage also produced better quality dried cocoa beans.

Benefits from the study

This study indicated the optimum drying conditions (air temperature and air flow rates) for drying of cocoa beans for continuous drying operation and/or for two stage drying operation.

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Graduate Research

None.

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