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Analysis of Rack Dryer Performance with Varying Inlet Air Temperature

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Abstract
The system for drying corn (Zea mays ssp. mays) is usually carried out naturally using solar heat as a source for drying. This situation is certainly less effective because it will require a large space and quite a long time. during the post-harvest rainy season the drying process will be hampered. One alternative tool that can be used for the corn drying process is a tray dryer. This research aims to determine the performance characteristics of rack dryers including drying room temperature versus time and dryer efficiency versus time. This research is using experimental method. The drying process uses a heating temperature of 65ºC, 70ºC and 75ºC with a drying air speed of 2 m/s repeated 3 times until it reaches a moisture content of 14 – 15%. The results of this research are that the greater the air temperature used to dry corn kernels, the greater the average temperature of the drying room. The average temperature of the drying room ranges from 54.59^{o}C during the drying process for an inlet air temperature of 65^{o}C, 56.55^{o}C during the drying process for an inlet air temperature of 70^{o}C, 58.63^{o}C during the drying process for an inlet air temperature of 75^{o}C. The best average drying efficiency was 11.9% at an inlet air temperature of 75^{o}C.

Keywords: *Dryer, corn, drying room temperature, drying efficiency*

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I. INTRODUCTION

Many farmers in Indonesia dry corn seeds naturally, still using sunlight as a source for drying, so this method requires a large drying area and a long drying time. Meanwhile, natural drying can only be done during hot weather or the dry season. There are two seasons in Indonesia, so during the rainy season the drying process will be greatly hampered. This will have a negative impact on the quality of corn and the income of corn farmers, improper drying will result in the quality of the corn being reduced and make the corn moldy, brown in color and smell musty, this will have a bad impact on farmers and they will experience losses [1]. Meanwhile, artificial drying is hampered by low efficiency, which is still below 60%, and degradation of the protein content in corn, especially if the air temperature for the drying process is more than 60°C [2]. Corn has a high selling price if the water content in the corn kernels meets the standards desired in the market, the Indonesian national standard determines the water content in corn, namely 13-14% [3].

An artificial drying system is needed as an alternative to overcome this problem, a rack type drying machine is one type of dryer that is often used in the drying process, drying using a tray drayer is one of the effective drying methods, the drying process with a tray drayer can be done at any time or does not depend on weather and space. Apart from that, drying with a rack type does not require a lot of labor. Based on the problems that have been raised, it gives an idea to study the drying method using a tray dryer, which is thought to be very helpful for farming communities to dry their corn harvest. In this stage, the characteristics are studied. drying corn with various drying operating conditions, namely at various inlet air temperatures and analyzing the temperature distribution and testing the performance of the dryer using a rack type drying machine.

The efficiency of a multi-level tray dryer type cocoa dryer by circulating hot air into the drying chamber. The inlet air temperature was varied, namely 60^{o}C, 65^{o}C, and 70^{o}C with the air flow rate kept constant at 6.37 m/s. The research results show that the time needed to reduce the moisture content of cocoa from 72.9% to 7.5% is 1.75-3.25 hours. Drying efficiency was obtained at 23.34% at an inlet air temperature of 60^{o}C, 26.56% at an inlet air temperature of 65^{o}C, and 29.21% at an inlet air temperature of 70^{o}C [4].

Research on the drying process using temperatures below 55°C was repeated 3 times until it reached a water content of 8 – 10% bk. Observation results showed that during the drying process the Rh outside the dryer was recorded at between 83.28% - 89.50%. Also the Rh in the dryer was observed and recorded to range between 86.58% - 97.91%. The moisture content of nutmeg seeds during the drying process decreased from 38.75% down to an average of 18.05% with details on shelf one 6.54%, shelf two 8.28% and shelf three 9.70% [5].

The process of drying corn using a vertical cylinder type dryer was tested 3 times based on a moisture content of 29% bw, 27.5% bw and 26% bw. The research results show that the time used to dry corn until it reaches a moisture content of 12-14% varies in each test. Performance test 1 takes 8 hours, performance test 2 takes 7 hours and performance test 3 takes 6 hours. But the drying rate for each performance test has almost the same value of around 5 kg H_2O/Hour. So the total drying efficiency in performance test 1 was 23.56%, performance test 2 was 26.90% and performance test 3 was 23.57%. [6]. Fast drying times are obtained at high air temperatures, whereas long drying times are obtained at low air temperatures. In this research, air temperature variations of 55°C, 60°C and 65°C were used, the results showed that the air temperature of 65°C produced the fastest drying time compared to drying at temperatures of 55°C and 60°C. Meanwhile, the longest drying time was obtained at an air temperature of 55°C. [7].

One of the most important drying factors in determining the quality of corn kernels is the water content. Drying aims to reduce the water content in the corn kernels to a condition where the water content in the corn kernels cannot reduce the quality of the corn kernels and the corn kernels do not grow mold. Based on the energy source, corn drying can be divided into natural drying and artificial drying. [8].

Drying corn kernels using a rack type dryer affects the drying rate and changes in the moisture content of the corn kernels or causes the moisture content to decrease. The higher the temperature and the longer the drying process, the faster the drying rate will be and the decrease in water content will be smaller or slower [2].

Research on corn drying using a fluidized bed showed that the higher the air speed, the faster the corn drying time. In this study, using a drying air speed of 7 m/s produced the fastest drying time while an air speed of 5 m/s obtained the shortest drying time. long. [9].

II. RESEARCH METHODS

This research is experimental research with a scheme as shown in the following figure.

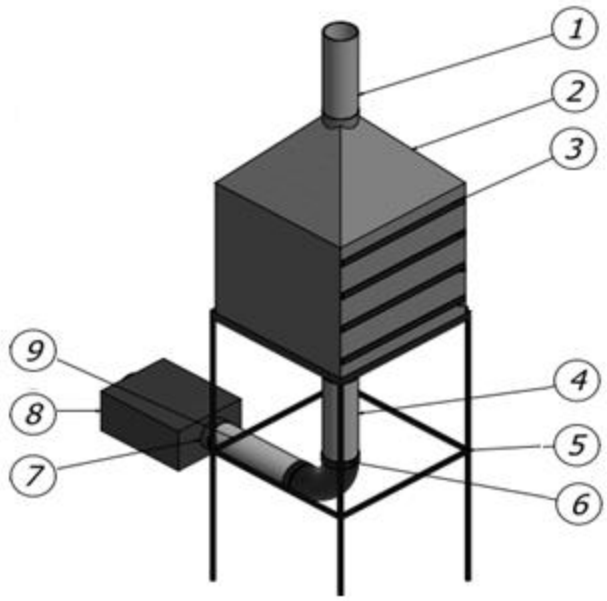

Figure 1. Dryer installation: 1. Output pipe, 2. Dryer box, 3. Rack, 4. Input pipe, 5. Frame, 6. Keni, 7. Sensor controller, 8. Heater box, 9. Blower pipe

In this study, two types of variables were used, namely the dependent variable and the independent variable. The dependent variable is a variable that is influenced by other variables such as the power used. By analyzing the dependent variable, it is hoped that an answer or explanation can be found regarding the problem being tested. The dependent variable in this research is the drying rate. Independent variables are variables that can be adjusted and determined according to testing needs. The independent variables used in this research are variations in the temperature speed of the heating drying room of 65ºC, 70ºC and 75ºC with an air speed of 2 m/s.

The research procedures carried out are as follows,

1. Turn on the dryer's power.
2. Set the temperature of the dryer using the specified temperature.
3. Adjust the air flow rate by the fan according to test requirements.

4. Put the corn seeds into the dryer weighing 2 kg with 0.5 kg each rack.
5. Weigh the ingredients every 30 minutes and record the mass of corn, drying room temperature, inlet temperature, outlet temperature and air speed until the corn moisture content is a maximum of 14%.
6. Repeat steps 2 to 5 with temperature variations at point 2 with temperature variations of 65°C, 70°C and 75°C.

III. RESULT AND DISCUSSION

During the research, data were collected every half hour after placing the corn in the dryer for 3.5 hours. Based on Fig 2, the graph of the relationship between drying room temperature and time is obtained. The drying room temperature is directly proportional to the time used to dry the corn itself. The longer the time used for the drying process of corn kernels, the higher the temperature of the drying room. The average temperature of the drying room ranges from 54.59°C during the drying process for an inlet air temperature of 65°C, 56.55°C during the drying process for an inlet air temperature of 70°C, 58.63°C during the drying process for an inlet air temperature of 75°C. This happens because the longer the drying time, the less water content in the corn and as a result the air temperature is used less to evaporate the water content of the material. The drying air temperature tends to increase with the longer the time used for drying.

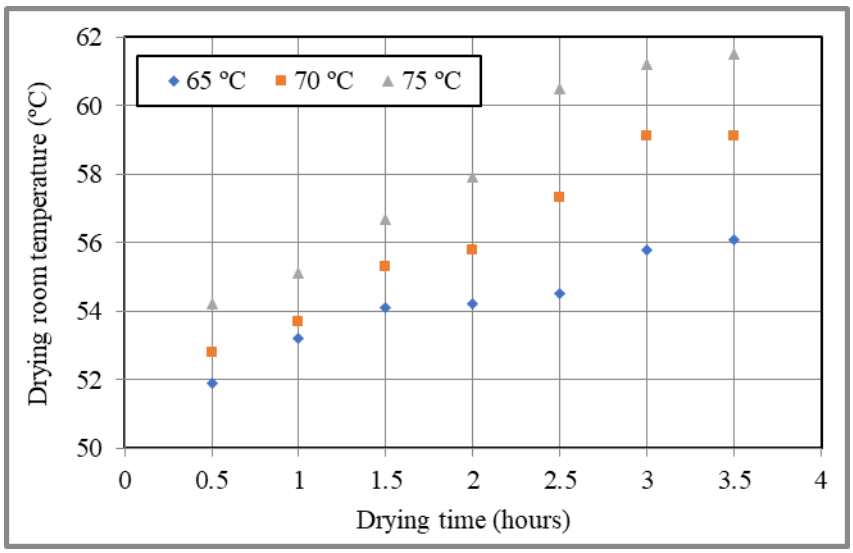

Figure 2. Graph of the Relationship between Drying Room Temperature and Drying Time

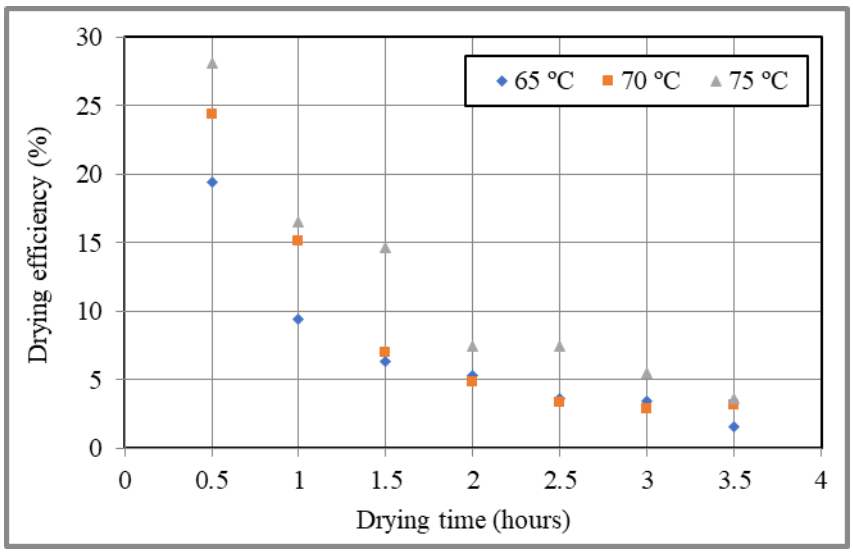

Figure 3. Graph of the Relationship between Drying Efficiency and Drying Time

Drying efficiency is influenced by the amount of heat absorbed and the heat used for the evaporation process, where the size of the evaporation process can be seen from the size of the mass evaporated. Efficiency can also be seen from the drying rate. The efficiency data concludes that the best efficiency is obtained at a temperature variation of 70ºC. The greater efficiency of the dryer in drying is obtained due to the influence of large useful heat and better changes in water content so that based on the final results the best data is found in these variations. The data obtained in the first 30 minutes of drying had a high efficiency because the amount of heat entering the drying chamber was smaller compared to the useful heat and was also influenced by the equipment remaining in the hot position first so that the temperature in the drying chamber increased (Fiq 3).

Fig 3 shows that greater efficiency can be influenced by the time used to record the data taken because the time the heater is at its peak heat point before the heater is turned off by the temperature sensor, the efficiency being small can also be influenced by the time the data is collected if the data is taken at that time. If the heater is turned off by the heater sensor, it will also have a big impact on the data taken, then the effect of time on efficiency itself will affect these two conditions, so the data obtained will definitely not be consistent or linear. The best average drying efficiency was 11.9% at an inlet air temperature of 75^{o}C.

IV. CONCLUSION

Based on data analysis of the drying process with an air speed of 2 m/s and a temperature of 65ºC 70ºC 75ºC it can be concluded that the capabilities obtained by the designed dryer. The greater the air temperature used to dry corn kernels, the greater the average temperature of the drying room. The average temperature of the drying room ranges from 54.59^{o}C during the drying process for an inlet air temperature of 65^{o}C, 56.55^{o}C during the drying process for an inlet air temperature of 70^{o}C, 58.63^{o}C during the drying process for an inlet air temperature of 75^{o}C. The best average drying efficiency was 11.9% at an inlet air temperature of 75^{o}C.

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