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DESIGN AND EVALUATION SMALL SCALE DOME DRYER OF CORN FOR SMALL INDUSTRY

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Abstract: Corn is still an important commodity for small farmer industries in Indonesia. However, one of the problems is the natural drying process with direct sunlight which is quite long and is often disturbed in the rainy season. Reaching 14% moisture content often takes up to 6-7 days so it is not efficient. This is because the direct drying temperature is relatively low, and when it rains it must be moved around, thus increasing labor costs. Several artificial dryers have been developed, but the price is relatively expensive so it is not affordable for small industrial scale. The purpose of this study was to design and evaluate a simple small-scale dome-type dryer. The results showed that the dryers that have been designed and made are quite practical and effective to use for small-scale farmers. Drying time from 35-40% water content to 13.5-14.5% within 2 days with an average drying temperature in the tool 40-56 ^{o}C.

Keywords: dome dryer; UV; corn; small-scale industry.

INTRODUCTION

Corn is one of the leading food crops in Indonesia. Efforts to cultivate corn plants continue to be improved by local governments both at the provincial and district/city levels. Productivity per hectare is increasing from year to year, even in 2020, in some locations it can produce corn up to 8 tons per hectare. Meanwhile, in North Sulawesi, corn production in 2015 was 300,490 tons per hectare [1], and in 2020 it was 920 thousand tons with a harvested area of 235,500 Ha, which makes North Sulawesi the eighth highest producer province in Indonesia [3].

One of the concerns in corn industry is post-harvest handling. The total amount of loss if post-harvest handling is not optimal can reach 5%. Post-harvest handling of corn consists of 5 (five) groups of activities, namely harvesting, transportation, drying, shelling and storage. Drying losses in post-harvest corn were about 0.5% and quality losses were up to 2% [10]. Corn postharvest handling activities actually aim to get good quality corn kernels, with the right harvest age, low harvest and threshing losses, low moisture content (14% for storage or 16% for marketing). The value of water content as above aims to avoid the growth of fungi and fungi that attack corn such as Aspergillus sp. which produce aflatoxin compounds or toxins that are harmful to human health. This good quality will affect the selling value and certainly have a positive impact on farmers' income.

Drying treatment at the farmer level is often done by aerating the corn on a roofed or unroofed shelf, and when the moisture content is less than 20% it will be easier to crush it to produce shelled corn. Low water content will reduce shrinkage in threshing which can reach 4%. Drying by direct drying, as is often done today, is relatively weather dependent. If it rains suddenly, it will take labor and effort to move it again to a place that is not disturbed by rain. This will be even more difficult if the weather changes quickly on the other hand, drying by drying takes a long time. Drying efforts using a dryer using fuel are relatively expensive and limited.

In the drying process, the migration of water and steam occurs due to the difference in vapor pressure on the inside and outside of the material [7]. The drying rate (drying rate; kg/hour) is the amount of water that is evaporated per unit time or the decrease in the water content of the material in a unit time. The drying rate usually increases at the beginning of drying and then remains constant and then decreases with time and the moisture content of the dried material decreases [4, 9]. The drying process has two main periods, namely a drying period with a constant drying rate and a period of decreasing drying rate. These two main periods are limited by the critical moisture content [12]. The critical moisture content is the lowest water content at which the rate of free water from inside the material to the surface is equal to the maximum rate of uptake of moisture from the material. In clothes, the moisture content when drying begins is less than the critical moisture content. Thus the drying that occurs is drying with a decreasing drying rate. The

change from a constant drying rate to a decreasing drying rate occurs at different levels of moisture content [2]

In some places, a simple type dome dryer has been developed for drying coffee cherries and beans. This dryer can overcome the problem of hot or rainy weather and day and night conditions, so that coffee farmers can increase their productivity [8]. Several dryers with gas fuel (LPG) and combined with solar energy have also been made for drying nutmeg seeds. However, LPG costs are relatively high if the drying capacity is up to about 1 ton of corn at a time, especially to help farmers who have less than 0.5 ha of land. For this reason, this research was carried out so that it could provide a simple, practical and economical alternative but with sufficient capacity for small-scale farmers.

The objectives of this research are to design and manufacture a small-scale dome-type corn dryer for a capacity of about 300 kg and to conduct evaluation of the prototype in terms of drying capacity, drying temperature, drying time and quality of results.

MATERIALS AND METHODS

1. Corn samples

Two categorize of corn that have been dried in the dome dryer, namely corn with husks and corn without husks. The corns were categorized as shown in figure 1.

(a) (b)

Figure 1. Corn samples (a) Corn with husks; (b) Corn without husks

2. Materials and Tools

The materials used in this research are mild steel frame, 6% UV plastic 120 micron, poly-carbonat, and several other materials. The drying floor will use a mixture of cement, stone and sand. The materials to be tested are corn with husks and shelled corn which will be taken from the area around Tondano town area. As an important part of this dome-type drying equipment system, the floor will be coated with a mixture of cement, sand and stone. It aims to keep moisture from the soil from affecting the humidity of the drying chamber

The tools used in this research are as follows:

1. Analog scales with a capacity of 10 kg, to calculate the weight of corn.
2. Digital Thermometer, to measure the

temperature inside the Dryer Chamber and outside the Dryer.
3. RH meter, for humidity measurement
4. Moisture tester, for measuring the moisture content of corn.
5. Camera, as a documentation tool and stopwatch.
6. Blower, to adjust the air flow
7. Timer for time calculation
8. Carpentry tools for making the dome dryer

3. Functional Design

1. Mild steel frame to support UV and polycarbonate plastic loads
2. UV (Ultra Violet) plastic to distribute heat evenly throughout the drying chamber
3. The base of the building is made of cement to keep moisture from below from disturbing the drying chamber.

Methods

This study uses the method of design, manufacture and testing. Technical test with drying treatment of corn with husks and corn without husks in shelled. The treatment will be made with 2 replications each with the amount of corn 100 kg per batch.

Figure 2. Trial of the dryer in the drying process

Figure 3. The appearance of the drying process in the dryer

Work Procedures

a) Design and manufacture a small-scale dome based on the initial design, with an additional 1 meter high from the design, and a width of 4.20 m.
b) Making the dome begins with coating the floor, which is then continued with the manufacture of a steel frame as a place for UV and Polycarbonate to be attached.
c) After the dome is completed built, the next stage is the evaluation test
d) Add 100 kg of corn with the husks, measure the initial moisture content, up to 30% moisture content. Observed for several days until the desired water content is reached
e) Recording of changes in the water content of the material is carried out every 1 hours for several days during the day. And also at the beginning of the day and at the end of the day.
f) Also note the drying temperature and the temperature outside the dome during the drying process
g) Treatment of corn without husks is also done the same as above.

The things that were observed were:

a) weight of corn before drying and after (kg)
b) corn moisture (percent)
c) temperature in drying chamber (oC)
d) the length of time required for drying to a moisture content of 14%
e) drying capacity(kg)

yield Quality.

RESULTS AND DISCUSSION

In harvesting corn, the water content is usually too high. This high water content is very dangerous if stored immediately. For this reason, it is necessary to continue with the drying process to reduce the moisture content of the corn so that it is safe for storage. By drying the corn is also easier to peel. Drying of corn can be carried out in several stages, namely a) drying of corn on the cob in the field, this method is usually used by farmers in areas that have rain-fed and dry characteristics where the preparation period for the next planting is not urgent, b) drying in the form of corn on the cob, and c.) drying in the form of shelled corn. For drying corn on the cob itself is divided into 2 forms, namely corn on the cob and corn on the cob without corn, but it should be noted that drying corn on the cob is not recommended because it takes a long time and the results are not good.

In this research, there are two categories of corn that are given drying treatment in this dome-type dryer: with husks and without husks. Drying of corn in the form of cobs without husks is attempted to reach a moisture content of 17-18% and drying of shelled corn is carried out until it reaches 14-15%.

In this manufactured dome dryer, the results showed that at the outside temperature of about 32 ^{o}C, the temperature inside the dryer can reach 56 ^{o}C. In order to achieve the target moisture content of the drying results of around 13-14 percent, it only takes 2 days. The average moisture content of corn before drying in this research is about 30-40%. The results of this study indicate that there is an increase in the effectiveness of the dryer that can collect heat so that the temperature inside can reach a high temperature of around 56 oC.

CONCLUSIONS

The small-scale dome-type dryer that has been made can dry corn on the cob with a moisture content of 30-40 percent to 13.5-14.7 percent for 2 days. The highest temperature inside the dryer can reach a temperature of 56 degrees where at that time the outside temperature is 32 degrees. Therefore, this dryer can be useful for small scale industry because of the simplicity and inexpensive.

REFERENCES

BPS 2019 Central Bureau of Statistics Jacarta Indonesia.

Brooker D, B Arkema, W F B , C.W Hall 1986 Drying cereal Grain The AVI Publishing Compan, Inc. Westport Connecticut.

Ditjen Food Crops 2021 yearly Report Ministry of Agriculture.

Dure, R, F. Wenur dan H. Rawung 2016. Corn Drying using Dryer with energy combination of Sun and Biomas Cocos Vol7 no 6.

Earle R L 1983 Unit operations in food processing 2nd edition Pergamon press Sidney.

Hall C W 1980 Drying and storage of agriculture crops AVI Publishing Company.

Henderson S M and R L Perry 1976

Agricultural Process Engineering The AVI, Publishing Company Inc Westport.

Kusmiyati A S and J Ratnawati 2021 Development of Solar Dryer Dome to increase coffee quality products. J Aptekmas Vol 4 No 4:25-32.

Mujumdar 2006 Handbook of indistrial drying, 3rd edition Singapura.

Purwadaria HK 2007 Technology of Corn Postharvest. Deptan-FAO, UNDP.

Syarrief R and H Halid 1992 Technology of Food Storage Teaching Materials. PAU

Pangan dan Gizi. Bogor: IPB.

Taib G 1988. Drying operation on agricultural product management PT Madyatama Sarana Perkasa Jakarta.