ISSN: 1411-4674

DRAYING OF CASHEW NUT IN SHELL USING SOLAR DRYER

Mursalim[1], Supratomo[1], Yuliani Shinta Dewi[1]

ABSTRACT

Generally farmers in Indonesia dried Cashew Nut in Shells (CNS**)** by spread them on the ground or on the flat floor which is called open-air sun drying. Obviously this method is not hygienic and results in significant loss of produce, especially due to contamination by dirt, dust, insect, animal and human interference. This research was conducted at pancana village of Tanete Rilau district in Barru regency by using of solar dryer to dry CNS and open-air sun drying as comparison, from September-October 1999. The results showed that solar dryer unit could heat dry air up to 78.7 ^{0} C maximum on ambient temperature of average 27.2 ^{o} C. Drying rate was 0.59 % m.c/hr, efficient of 64 % and quality grade was M_1 based on CNS standart in Indonesia.
Key wods : Cashew Nut, Solar Dryer

BACKGROUND

Cashew has become one of the valuable commodity due to the marketing prospect fo domestic and even for export. World-wide trading of cashew divided into two products which are Cashee Nut in Shells (CNS) and cashew Nuts (kernel). Indonesian export this days are 75% for CNS and only 25% for kernels (Anonymous,1998).

Quality of CNS in the market determined by some factors and the most common are shape (amount/kg), mosture content (%) and losses (%). One of the most important postharvest handling is drying process. Drying process is very important to reduce moisture content to the level that save for strorage.

Using solar energy as an alternative energy source for a dryer unit can prevent problems which occur during the open-sun drying, boisedes could reduce drying time by a half, increase quality of CNS and at the end could emphasize the cost.

The main objective of this research was to study the drying characteristic of CNS such as moisture content, drying rate, efficiency and quality of the product.

[1]Department of Agricultural Engineering, Hasanuddin University

RESEARCH METHOD

A. Description of Solar Dryer

Drying unit whish used on this research was a modified cabinet dryer with natural convection system. This solar dryer unit consist of drying chamber of 120 cm long, 80 cm wide and 40 cm height, the walls are made from painted black plywood and also insulated with sawdust on the side walls. It is glazed on top with a single plastic cover tilted at 45 ^{0} and 28.28 cm height 9to reduce the reflective losses of solar radiation entering the unit).

Ambient air enters the cabinet through twelve holes with 1 inchi pipe at the bottom, distance between each hole is 20 cm, and 5 cm of *chsrcoal spread among the holes. Heated air escaped through the hole of bamboo stick which* placed below the cover. The painted black interior surfaces are made to absorb the solar radiation transmitted through the cover and thin layer of charcoal act as collector as well as insulation.

B. Testing Procedure

The research was conducted in two stages, firstly to see the technical performance of solar dryer without the product to be dried, includes highest temperature and when it's reached (repeated 3 times). Secondly with the product inside, how many times needed to reach the proper moisture content (repeated 4 times). And at the same time open-sun drying was conducted as control.

Six thermometers were used on this research, two were placed outside to see ambient temperature, two were placed inside to see the temperature of heated air and two were placed in bamboo's holes to see the escape air, all are in dry bulb and wet bulb temperature.

Technical permormance procedure, the test started at 07.00 am – 18.00 pm and every hour temperature changing was observed and resulted data were used to find relative humidity from psychometric chart.

Drying process, for each test 15 kg of CNS were used with dimension of (3.3 – 3.8 cm long), (2.3 – 3.15 wide) and 1.7 thick. Weight of the grain are 4.7 – 6.9 gram and amount of 133 – 165 grains/kg. The samples were sorted manually according to the shape and the weight. It started from 08.00 – 16.00 on day I and from 08.0 – 12.00 on day II.

CNS to be dried are placed on single simple tray with wire mesh at the bottom which placed a few centimeters above collector, so that the product directly receives solar radiation. The samples were weighted and overturned every two hours. Temperature was observed every hour for all the sixth thermometers. The drying process stopped after twelve hours (one and a half days).

For sun-drying as control, a concrete mat was used. During all experiment, the same testing procedure and the same amount of samples were also used.

C. Data Analysis

1. Relative Humidity (RH) of the air and dew point temperature are determined by using Psychometric Chart and both wet and dry bulb temperature data.
2. Determining the intial moisture content of CNS samples in thelaboratory by using method of SMP-345-1985,ISO2291-1980 by expression :

$$\% \text{ m.c.} = (M_1 - M_2) \times \frac{100}{(M_1 - M_0)}$$

where M_0 is the weight of the cup, M_1 is the weight of the wet sample and M_2 is the weight of completely dry sample, all in gram.

3. Determining the moisture content based wet weight (wet basis) by the ecpression :

$$\% \text{ w.b.} = \frac{A}{A+B} \times 100\%$$

Where *A* and *B* are the weight of water vapor and solid of CNS in kg.

4. The weight of water evaporated (M_w) from CNS determined by the following expression :

$$Mw = \frac{(M_{in} - M_f)}{(100 - M_f)} \times m$$

where M_{in} and M_f are the initial and finalmoisture content of CNS, and *m* is the weight of sample to be dried in kg.

5. Determining the rate of drying (W) during the process based on moisture content level has given the relation :

$$W\ (\%\ m.c.) = \frac{(M_{in} - M_f)}{t}$$

where *t is* the drying time in hour.

6. To determine the efficiency of drying, firs we need to know latent heat (h_{fg}), water evaporated (M_w), and energy balanced (Qtotal) during the process, then the efficient (*n*) can be expressed by the equation

7. $$n = \frac{Mw \times hfg}{Q_{total}} \times 100\ \%$$

RESULTS AND DISCUSSIONS

A. Temperature and Humidty

Temperature and humidity of air play an important role in the drying process. Average temperature inside solar dryer during the technical test 78.7^0 C. With the maximum one reached at 13.00 pm and average temperature of outgoing air was 50.8^0 C. This level of temperature is save for CNS drying because above 80^0 C could caused cashew Nut Shell Liquid (CNSL) come out from mexocarp layer can damaged and toxin the kernels.

During the drying processof CNS, average temperature was 61.5^0 C, temperat ure of outgoing air was 48.2^0C and ambient temperature was 26.9^0C. Figure 1 & 2 show the temperature curves which was comparison of temperature during technical test and the drying process.

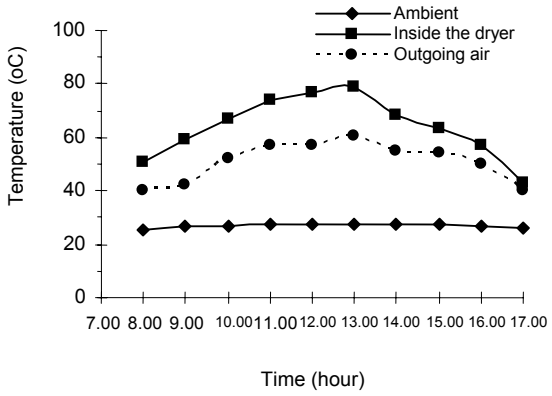


Fig.1 Temperature (0C) VS Time (hour) during technical test.

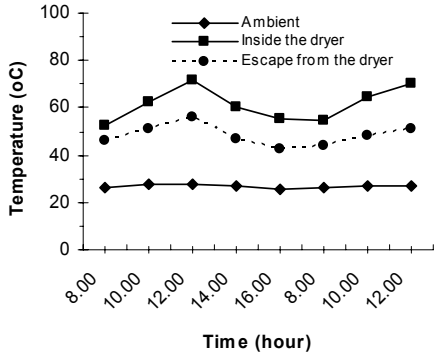


Fig.2 Temperature (0C) VS Time (hour) during CNS drying process

Average relative hunidity (RH) inside the dryer during technical test conducted was 31% with ambient RH of 76.6%. And during the drying process, RH inside the dryer was 36.0% with ambient RH of 89.3%. Figure 3 & 4 show the humidity curves for both sun-drying and inside solar dryer.

The air humidity was influenced to the transfer of moisture from interior to the surface of the product, in this case was CSN. Humidity was reverse condition of the temperature, the highest of temperature was the lowest of humidity.

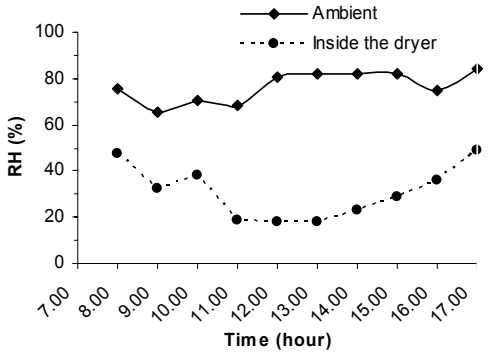


Fig.3 Relative Humudity (%) VS Time (Hour) during technical test.

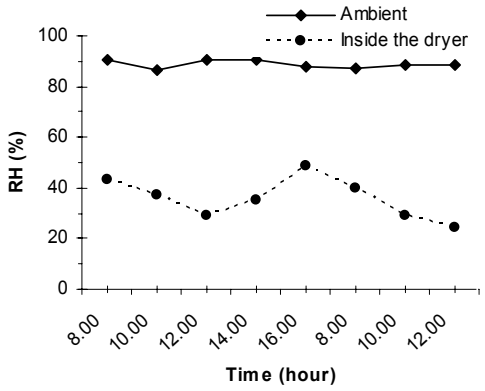


Fig.4 Relative Humudity(%) VS Time (Hour) duringCNS drying process.

B. Moisture Content and Drying Rate

The initial moisture content of the sample to be dried was 14.9 % wb. This level of moisture is quite high because samples that use are fresh harvested of CNS.

After dried, the final moisture content of samples in solar dryer was 7.79 wb and from sun-drying time. It proved that solar dryer could speed up the removal of moisture content because of the existence of a collector which can increase the temperature inside the box.

During the observation, it was found that there are three kind of moisture content removal process, which are quick (surface drying), slow and very slow one. Figure 5 shows the curves of moisture content versus drying time.

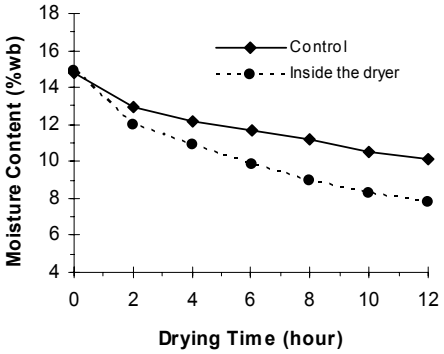


Figure 5. Moisture Content (%w.b.) VS Drying Time (Hour)

Drying rate calculation of CNS resulted 0.59% m.c./hour. It depend upon the rate of moisture migration from the interior of the product to the surface, which naturally depend on the type of material to be dried.

In the case of CNS, drying rate can be influenced by the existence of CNS in the shell that could make water evaporation from interior to the surface of CNS become slower.

C. Drying Efficiency

The evarage of drying efficeny of CNS using solar dryer was 64%. This is caused by solar energy that was absorbed by collector and energy provided by the drying air, bort are used to evaporate water from CNS inside the drayer.

The efficiency of sun-drying only depends on energy that was provided from absorption by the surface of CNS which exposed directly to the sun, therefore efficiency of sun-drying was 39.7%.

D. Quality of The Product

The result showed that quality of CNS that was dried in solar dryer included M_1, level according to the stardard of CNS in Indonesia. Also added that dried CNS from solar dryer contain less amount of CNSL in the sell and the epidermis of kernel can be easily removed by hands. These fact influenced losses that happened during post-harvest

handling. Make them less than ever, which is proved by higher peercentage of hole-piece of kernels. The kernels looked bright-white and clean whitout black spot or toxin sign.

CONCLUSIONS

From the above analysis, it can be concluded that under the caurrent test perfomance, the solar dryer had a better overall results, resulating in a first class quality (M_1) and germination of the dried products, as compared to teh sun-drying.

By these resultt could reduce drying time by a half and improved the selling price of kernels and at the end could help farmers in rular asreas to have better income. However, further inprovement of this model is still required, especially taking into account more paremeters involved.

REFERENCES

Anonymous, 1998. Research Development of Cashew. Volume VI, No. 2 Center of research and Development of Industrial Plants. Bogor

Brooker, D. B., F. W. Bakker and C. W. Hall, 1982. *Drying Cereal Grains,* The AVI Publishing Company Inc. Westport Connecticut.

Holman, J. P., 1984. *Heat Transfer.* Fifth Edition. McGraw-Hill, Ltd.

Jansen, J. Ted., 1995. *Solar Engineering Technology* (Translated by Wiranto Arismunandar)
PT. PRADNYA PARAMITA.

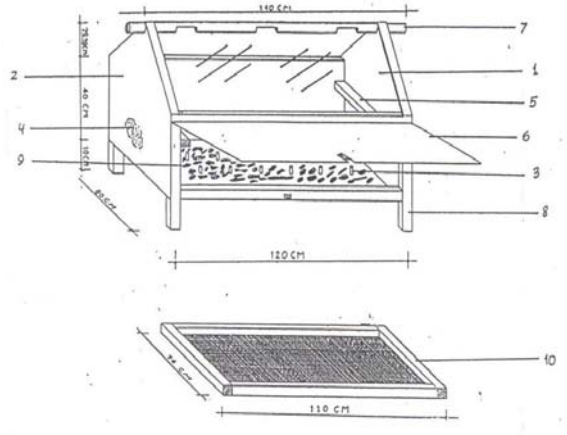
Saragih Y. Pieter and Yadi Haryadi, 1997. *Cashew,* Agronomy and Shells Opening. Penebar Swadaya, Jakarta.

Appendix. Components of Solar Dryer

Sodha S. Mahendra, Narendra K. Basal, Ashvini Kumar, Pradeep K, Basal and M. A.

A. Malik, 1987. *Solar Crop Drying.* Volume I & II..CRC Press. Florida

Lampiran.



Picture's Explanation :

1. Trasparent Cover (plastic)
2. 140 cm long of Bamboo for outgoing air
3. Holes of 1 inch pipe for inlet air
4. 5 cm thick of chalcoal
5. Single tray
6. Door of the dryer
7. Walla of the dryer
8. Legs of the dryer
9. Insulation
10. Thermometer