IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

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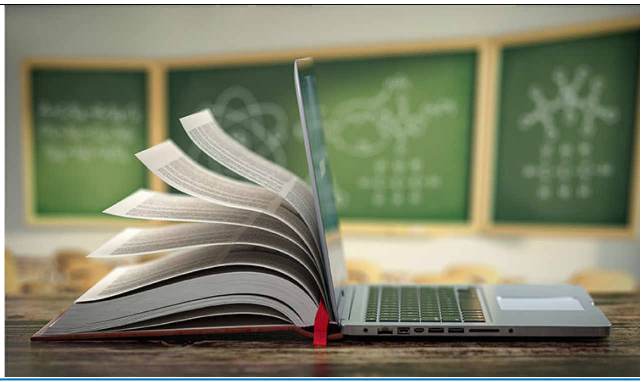
To cite this article: W Warji and T Tamrin 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **757** 012027



Hybrid Dryer of Cassava Chips

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Abstract. Hybrid type dryer is a dryer whose energy source comes from solar energy and additional gas, electricity or biomass energy. This dryer has transparent walls and is closed so that the sun's heat can enter the drying room, but rain cannot enter the drying room. This dryer is equipped with a fan that serves to push the heat so that it spreads throughout the drying room. This dryer is equipped with an exhous fan so that moisture is sucked out of the drying chamber. The main source of drying energy comes from solar energy, when the drying cloud is assisted by additional energy and when it rains the main drying energy comes from biogas combustion energy. The hot air flow control slot is designed in the drying chamber so that hot air can flow between the heating racks. The average air temperature in the chamber are 44.5 ºC, 47.3 ºC and 56.3 ºC with heating sources of solar energy, electricity and solar energy with electrical, respectively. Cassava chips can be dried in a hybrid dryer. The initial moisture content of 60% decrease to 10% - 12% wet basis. Drying chips using solar energy requires 18 hours of drying, for 16 hours using electrical energy, and 12 using a hybrid of solar energy with electrical energy.
Keywords: Hybrid Dryer; Cassava Chips; Heat Exchanger; Solar Energy

1. Introduction

Cassava is an agricultural commodity that has great potential. National cassava production continues to increase, production in 2008 was 21,756,991 tons [1], production in 2009 increased sharply, amounting to 22,039,145 tons [2], and 23,093,522 tons in 2010 [3], while in 2012, 2013, 2014, and 15 reached 23,922,075 tons, 23,936,921 tons, 26,421,770 tons, and 22,906,118 tons [4,5,6]. The cassava can be processed into various industrial materials, including bioethanol, snacks, analog rice, animal feed, and tapioca flour. Tapioca flour is the largest product made from processed cassava. The processing of cassava into tapioca flour produces solid waste and liquid waste. The liquid waste of tapioca flour has been used as a source of biogas. Meanwhile, the cassava chip dryer still uses direct solar, where direct drying can be converted into drying using a hybrid dryer whose energy source is from the sun and additional fuel from biogas.

Drying is basically the process of removing or removing the water content of the dried raw material to a certain content so that the material is not easily damaged. Drying can be done by drying using solar or by using artificial tools. The cassava will dry more quickly if the cassava is chopped first. Cassava chips that can be processed for the process of making flour should be dried to a moisture content of 12% - 14%. Drying the cassava chips is necessary for the drying process. Therefore, it is designed to build a rack type hybrid dryer. Hybrid drying systems utilize solar energy with the addition of other energy sources (electricity, fuel oil, biogas, LPG, etc.). The purpose of this study was to test the performance of a rack type hybrid dryer for drying cassava chips with three treatments, namely drying using solar, drying using electric energy and drying using solar and electrical energy.

IOP Conf. Series: Earth and Environmental Science **757** (2021) 012027 doi:10.1088/1755-1315/757/1/012027

2. Materials and Methods

2.1. Materials and tools

The tools used in this study were rack-type hybrid dryer (**Figure 1**), cassava chopper, knife, bucket, digital scale, manual scale, oven, aluminum foil, dessicator tube, cup, and thermometer. The material used in this research is cassava in the form of chips.

Figure 1. Hybrid dryer

2.2. Methods

This research was conducted in three treatments with three replications. The treatment is drying using sunlight, drying using electrical energy, and drying using sunlight plus electrical energy (hybrid). The raw material used in each treatment for each replication is 30 kg. After that, observations were made in the form of changes in drying temperature, decreased moisture content, total drying time, drying rate and calculation of the amount of energy needed in the drying process.

2.2.1. Cassava chips preparation. Cassava is peeled with a knife and then washed thoroughly. After obtaining the peeled cassava, the cassava is chopped with a thickness of ± 2 mm using a chopper to get a chip shape. Chip-shaped cassava is weighed as much as 30 kg, then the cassava chips are divided into five parts, each portion being 6 kg for the five racks.

2.2.2. Drying of cassava chips. The implementation stage of this research is carried out as follows: after all the materials and equipment are ready, then the initial temperature is recorded. The temperature recording is done by looking at the thermometer on each shelf and the thermometer that is placed outside the device as the ambient temperature. In the first two hours the temperature is seen every 15 minutes, this is done to determine the increase in temperature increase in the dryer and then the temperature is seen every 1 hour until the material dries with a moisture content of 10% - 12%. Sampling for the calculation of the moisture content of cassava chips is taken on each shelf. The sample taken is the sample that is in the middle of the shelf. Sampling was done before the material began to dry and every 2 hours. After that the sample is wrapped in aluminum foil and put into a dessicator tube, this is so that the water content in the material does not change. Measurement of water content is done by weighing the sample and then placing it in a plate that has known its weight. The sample was put in an oven with a temperature of 105^{o} C for 24 hours then weighed again.

Figure 2. Chips cassava on the rack

The process of drying cassava chips **(Fig.2**) was carried out with three levels of treatment, namely drying using solar drying using electrical energy and drying using sunlight and electrical energy with three repetitions, then observed. Subsequent repetitions were performed in the same manner at different times.

2.3. Measurement of water content

The water content is calculated before drying and every 1 hour which aims to determine the amount of water evaporated from the material. Measurement of moisture content was carried out by weighing a sample of cassava chips and then placing them in a plate with known weight. The sample was put in an oven at 105o C for 24 hours then weighed again. The water content of the material shows the amount of water content per unit weight of the material. In this study, the moisture content used was based on wet basis (bb). The determination of the moisture content of the material based on the wet basis in the calculation applies formula (1).

$$m_b = \frac{W_a}{W_b} x100\% \qquad (1)$$

Where, m_b is water content of cassava chips; W_a is water weight of cassava chips; and W_b is Wet material weight.

2.4. Measurement of dryer temperature

The temperature recording is done by looking at the thermometer on each shelf and the thermometer that is placed outside the appliance. In the first two hours, the temperature was seen every 15 minutes, then the temperature was seen every 1 hour.

Drying time is the time it takes to dry the cassava chips starting when the material is exposed to sunlight or when the tool is turned on until the dry material with an average moisture content of the sample reaches 10% - 12% wet basis.

3. Results and Discussion

3.1. Dryer Chamber Temperature

Testing with a heat source from sunlight shows that the temperature distribution in the drying room is influenced by the heat of the sun. The hot air in the room is captured so that the temperature is higher, higher than the temperature of the air outside. This is because short wave radiation from the sun with large energy is propagated through transparent plastic (conduction process) which is then partially reflected by the surface of the material (the reflected waves are long waves).

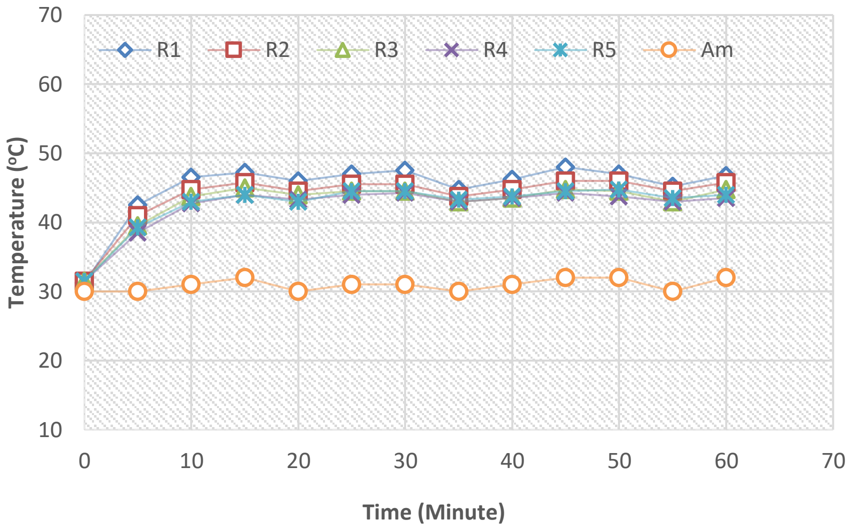

Figure 3. Dryer chamber temperature of heat source from solar

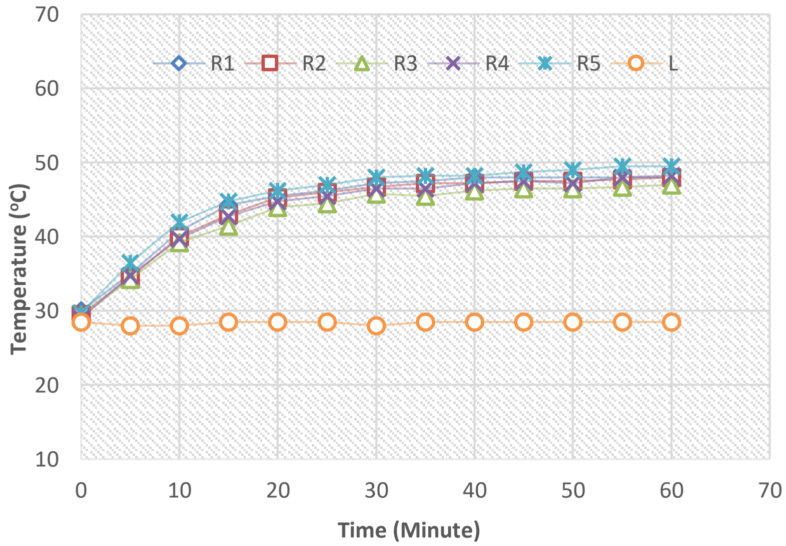

Figure 4. Dryer chamber temperature of heat source from electric

The air temperature in the drying chamber was initially 30 ºC then increased to an average of 44.5 ºC and was relatively stable at 44.5 ºC. The temperature reaches a stable condition after heating for 10 minutes, as shown in Figure 3. Meanwhile, the ambient temperature is around 31 ºC. The temperature of dryer chamber increase of 13.5 ºC in the compared to ambient temperature.T he increase in temperature occurs because the sun's heat enters the dryer and is trapped in the drying room, this heat is used as a drying energy source.

Drying with an energy source from electric heating shows that the temperature on the five shelf is higher than the other racks, this is because this shelf is close to the heating source. The dryer temperature with an electric heating source is around 47.3 ºC. This heat is higher in comparison to shu, whose heating source is from solar energy. The temperature of 47.3 oC began to reach after 30 minutes of heating. The graph of the heating room temperature which contains the source of electrical energy is presented in Figure 4.

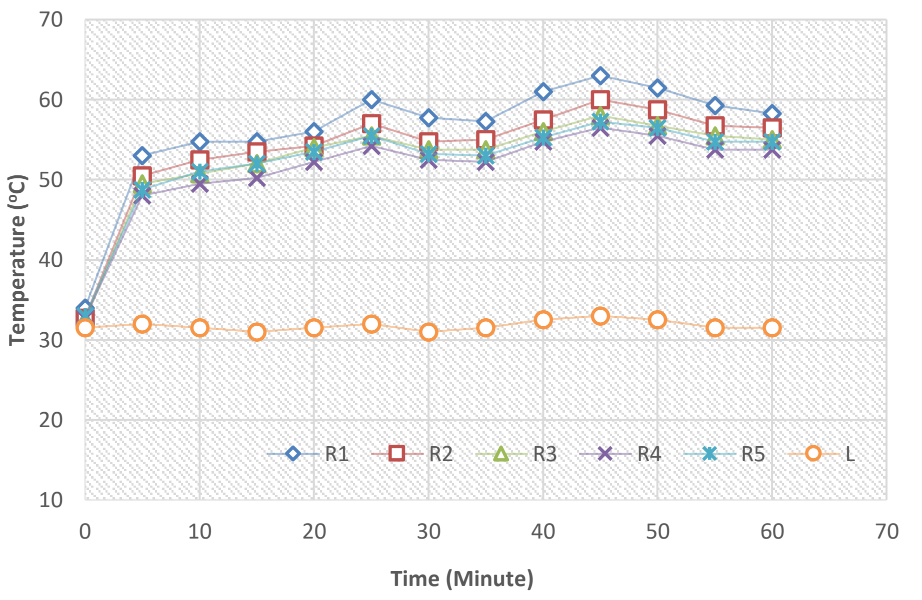

Figure 5. Dryer chamber temperature of heat source from solar and electric

Hybrid dryers with energy sources from the sun and electricity have a temperature of 56.3 °C. This temperature is reached after the drying process for 10 minutes. This temperature is higher than solar or electric energy. This hybrid dryer has the potential to dry cassava chips faster than solar or electricity sources. The temperature of the top and bottom shelves is higher than the others. The upper shelf temperature is high because it gets the most solar energy; while the bottom shelf gets energy from an electric heater. The graph of the drying room temperature with solar and electricity sources is presented in Figure 5.

The drying process uses electrical energy and sunlight so that the drying process can be done in a hybrid manner. This can be done if one of the energy sources used cannot perform the drying process optimally. For example, if the weather is cloudy or rainy, the drying process cannot use sunlight but can be replaced by using electrical energy and carried out in a place that is not exposed to rain. Vice versa, if electrical energy cannot be used, drying can be done using sunlight. So that in the drying process using sunlight and electrical energy, drying using a hybrid system can be applied. Drying using sunlight and electrical energy will have maximum results if the two energies are used simultaneously.

3.2. Drying of cassava chips

The load test was carried out using 30 kg of cassava chips. There are 10 shelves and each shelf is filled with 3 kg of cassava chips. Cassava chips are arranged evenly on each shelf without piling up. Temperature of cassava chips drying is showed in Figure 6.

The drying room temperature in the drying process of cassava chips averaged 34.8 °C, 37.2 °C and 41.56 °C with solar, electricity, electricity and solar energy sources, respectively. This temperature is lower than the drying temperature without material as shown in Figures 3, 4 and 5.

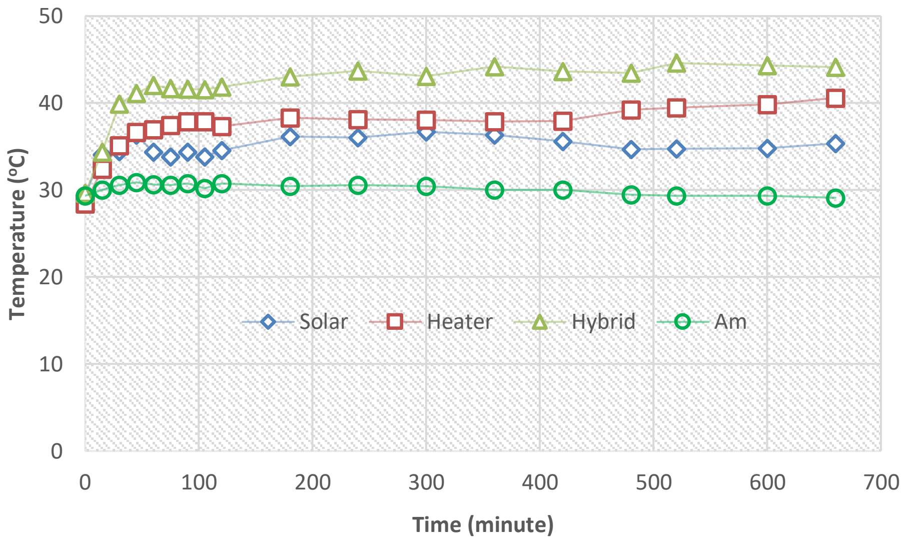

Figure 6. Temperature of cassava chips drying

3.3. Water content of cassava chips

The average moisture content of the initial material on drying using sunlight is 60.4% wet basis and the average final moisture content is 10.3% wet basis. Based on the observations presented in Figure 7, it can be seen that the water content decreases with increasing drying time. The longer the drying time, the less moisture content contained in the cassava chips. A decrease in the water content of the material is closely related to a decrease in the mass of the material, because the water evaporating from the dried material can be seen from the decrease in the mass of the material.

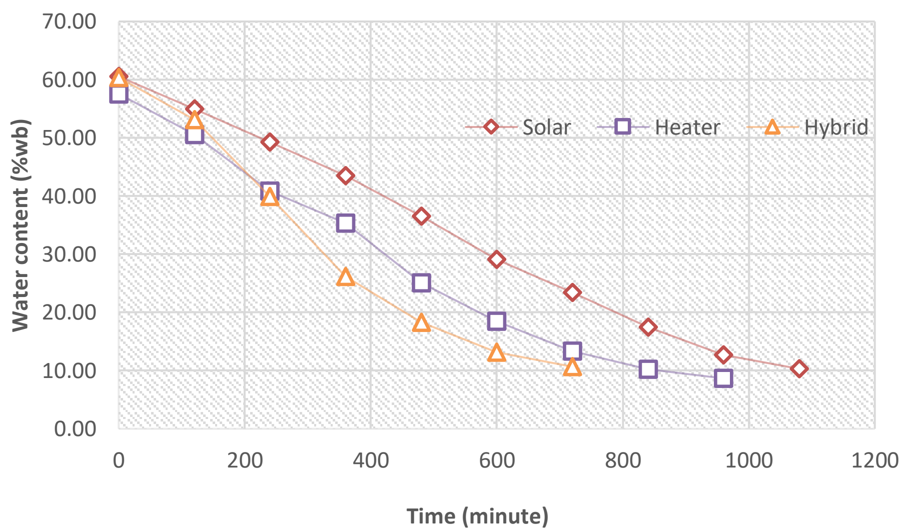

Figure 7. Water content of cassava chips

Drying using electricity and sunlight is the most efficient drying of materials. The decrease in water content appears to be faster than using sunlight or electrical energy. The time required to dry the material to obtain a moisture content of 10% - 12% wet basis is 12 hours. The average water content of the initial material from all replications was 60.39% wet basis, while the final moisture content was 11.6% wet basis.

The graph in Figure 7 shows that the decrease in moisture content with respect to drying time has the same pattern, which follows an exponential pattern. At the beginning of drying, the rate of reduction in water content increases sharply and is almost stable until it is close to 20% moisture content, but then the rate of decrease in water content gradually decreases until it is almost zero. The drying process is divided into 2 drying periods, namely a period of constant drying rate and a period of critical moisture content [7].

4. Conclusions

Cassava chips can be dried in a hybrid dryer. The initial moisture content of 60% decrease to 10% - 12% wet basis. Drying chips using solar energy requires 18 hours of drying, for 16 hours using electrical energy, and 12 using a hybrid of solar energy with electrical energy.

Acknowledgment

The research was financially supported by Penlitian Inovasi Universitas Lampung 2020.

References

[1] Biro Pusat Statistik (BPS). 2008. Produksi Hasil Tanaman Pangan Sekunder di Indosesia. http://www.bps.go.id/sector/agri/pangan/tables.shtml.
[2] Biro Pusat Statistik (BPS). 2009. Luas Panen, Produktivitas dan Produksi Ubi Kayu Menurut Provinsi Tahun 2009. http://www.bps.go.id/sector/agri/pangan/tables.shtml.
[3] Biro Pusat Statistik (BPS). 2012. Luas Panen, Produktivitas dan Produksi Ubi Kayu Menurut Provinsi Tahun 2010. http://www.bps.go.id/sector/agri/pangan/tables.shtml.
[4] Biro Pusat Statistik (BPS). 2013. Luas Panen, Produktivitas dan Produksi Ubi Kayu Menurut Provinsi Tahun 2012. http://www.bps.go.id/sector/agri/pangan/tables.shtml.
[5] Biro Pusat Statistik (BPS). 2014. Luas Panen, Produktivitas dan Produksi Ubi Kayu Menurut Provinsi Tahun 2014. http://www.bps.go.id/sector/agri/pangan/tables.shtml.
[6] Biro Pusat Statistik (BPS). 2016. Produksi Ubi Kayu Menurut Provinsi (ton) 1993- 2015. http://www.bps.go.id/ linkTableDinamis/view/id/880.
[7] Johanes. 2007. *Uji Kinerja Alat Pengering Tipe Rak pada Pengeringan Pati Ubi Kayu*. Fakultas Pertanian. Unila. Lampung.