Application of Cooling Dehumidification in Drying Machines to Drying Harvested Herbal Plants

S. Sudirman, I Nyoman Gede Baliarta and I. D. G. Agustriputra
Politeknik Negeri Bali, Indonesia

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Abstract: Drying is a suitable alternative for post-harvest management, especially in countries such as Indonesia where distribution facilities and post-harvest handling are not good. It should be noted that more than 20% of damaged or decayed crop yields are preserved by drying to increase yields. shelf life. This is the oldest and most effective method of lowering moisture content to slow down spoilage by microorganisms. Likewise with ginger agricultural products that require post-harvest handling, so that the product can be stored for a long time, but with the aroma and texture that does not change much. The aim of this research is the dehumidification system of the ginger drying machine which efficiently dries fresh ginger at a temperature of 40 degrees Celsius. With a time of 9 hours, dried fresh ginger with a dehumidification system dryer resulted in an average weight reduction of 81% of fresh ginger with an average moisture content of 9.2% ginger powder.

1 INTRODUCTION

Keeping farm produce fresh is the best way to maintain the nutritional value of the product, but most storage techniques require low temperatures which are difficult to maintain throughout the distribution chain. On the other hand, drying is a suitable alternative for post-harvest management especially in countries like Indonesia, which have poor distribution and post-harvest handling facilities. It should be noted that more than 20% of damaged or rotting crop yields are preserved. by drying to increase shelf life (Singham Pragati and Birwal Preeti, 2014). It is the oldest and most effective method of lowering water content to slow down spoilage by microorganisms (Jayashree, et.al, 2017).

The drying process can also be carried out by flowing hot air on the material in a closed room (close drying). There are many advantages of closed type drying, namely clean ingredients, natural colors, low contamination of impurities and better taste. Drying that is too fast can damage the material, because the surface of the material dries too quickly so it can't be balanced with the speed of water movement in the material towards the surface of the material. On the other hand, drying operations with temperatures that are too high can damage the material (Kumar,et.al 2016) One method of drying agricultural products used is a dehumidification system. Where the process is carried out at a temperature that is not too high, around 40 0C - 600C (Jayashree, at al, 2014).

The stages of processing fresh ginger rhizomes into ginger simplicia are carried out through several stages, namely the process of sorting, washing, chopping or cutting, drying, final sorting, packaging and storage (Sembiring, at al, 2012). Inappropriate harvesting can cause the rhizomes to easily experience physiological damage so that it can reduce the quality, therefore further handling needs to be done, one of which is the drying process (Ananingsih, at al, 2016). One of the purposes of drying is not only to increase the selling value but also to overcome the occurrence of excess supply during the harvest season (Harold and Edwar, 2016).

Moisture content in fresh agricultural produce is the basic cause of spoilage. Removal of moisture from food inhibits many moisture-mediated deterioration reactions and prevents the growth and reproduction of microorganisms (Muliterno, at al 2017). If water is removed then the shelf life of agricultural products can be increased. Water removal also reduces storage and transportation costs by reducing the weight and volume of the final product. The quality of dehydrated food products is influenced by drying conditions such as temperature and air

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velocity, air flow rate, relative humidity, thickness and surface exposed to drying (da Silva, at al, 2016) .

The process of removing moisture from agricultural materials is very energy-intensive. The drying process consumes considerable energy, about 20-25% of the energy used by the food processing industry or 10-25% of the energy used in all industries in developed countries. Therefore, energy along with time efficiency is one of the most significant design and operating parameters in food processing (Raquel and Guiné, 2018). The low thermal conductivity and case hardening of the material are the main factors responsible for slowing down the convective drying.

2 METHODS

2.1 Equipment

The concept of the drying machine made is, The air that enters the evaporator contains water vapor that is taken from the material being dried. The air entering the evaporator will condense and turn into water, then the water is accommodated in the safety tray under the evaporator and flows out through the drain pipe. Dry air coming out of the evaporator flows into the air duct and is heated using an electric heater. So that it is hot enough to evaporate the water content in the dried material. Hot air containing water vapor from the dried material flows into the evaporator to be condensed again, so that the water vapor turns into water and is removed through the drain pipe.

The main refrigeration system components used are the compressor, condenser expansion valve and evaporator. The refrigerant used is R134a.

The concept is applied to the drying machine schematic in Figure 1.

2.2 Procedure Experiment

Fresh ginger to be dried is local ginger. Before being cut into pieces with a thickness of 2 mm, the fresh ginger is washed. Ginger that has been cut to size.

The smart control panel is set with the temperature setting of the drying chamber at a temperature of 40 degrees Celsius, while the relative humidity is at 40%.

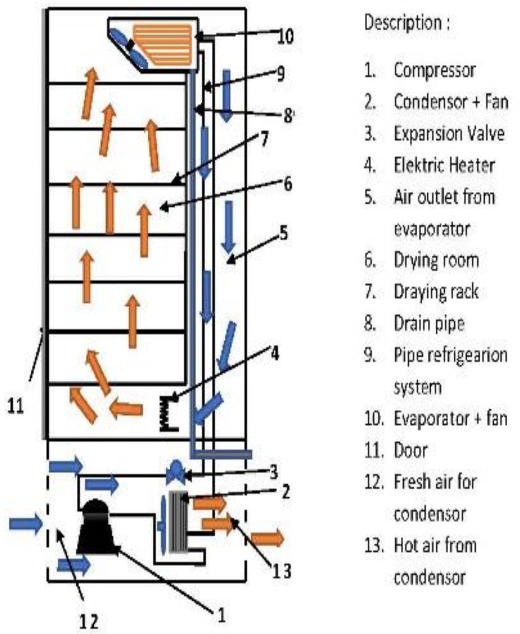

Figure 1: Schematic of dehumidification system dryer machine.

This ginger drying machine was tested with 3 experiments, each experiment was carried out for 7 hours. There are 6 drying racks, filled with 500 grams of fresh ginger. So the dried ginger during the experiment was 3 kg. After 7 hours, each will be weighed to find out how much ginger weight reduction occurred. To facilitate the measurement of dry ginger content, the dried ginger in each experiment was made into powder using a blender. With a moisture meter, the moisture content of the powdered ginger was measured.

3 RESULTS AND DISCUSSION

After being carried out with 3 tests under the same conditions, results were obtained and made as in Table 1.

The condition of the drying chamber, the temperature and humidity, is shown in Figure 2.

Table 1: Experimental results.

Experiment	Shelf	Fresh Ginger (Grams)	Dried Ginger (Grams)	Weight reduction (Grams)	Weight Loss Percentage	Moisturer %
1	1	500	99	401	80%	9
	2	500	97	403	81%	
	3	500	94	406	81%	
	4	500	92	408	82%	
	5	500	92	408	82%	
	6	500	90	410	82%	
2	1	500	111	386	78%	9,2
	2	500	107	391	79%	
	3	500	104	399	79%	
	4	500	98	402	80%	
	5	500	93	406	81%	
	6	500	91	407	82%	
3	1	500	107	391	79%	9,4
	2	500	103	399	79%	
	3	500	95	403	81%	
	4	500	92	408	82%	
	5	500	90	410	82%	
	6	500	89	411	82%	

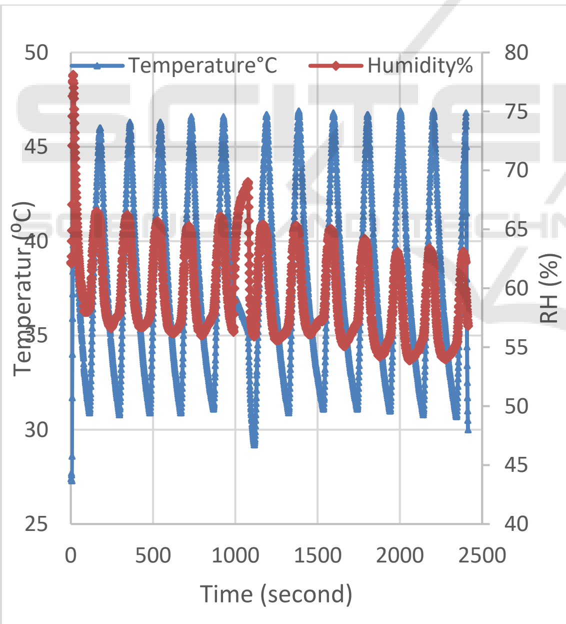

Figure 2: Drying chamber temperature and humidity.

Control the dryer using the ON/OFF control. The machine operates for 7 hours. On/off the refrigeration engine is controlled by Humidystat. Set at 60% humidity. The room temperature is controlled by a thermostat, the setting temperature is 40 oC and this controls the power on and off of the electric heater.

For 7 hours, the electric heater is off for 12 times. When the heater and compressor start for the first time, the temperature and humidity of the room increase, when the heater is off, the temperature still rises from 40 oC to 45oC, while the humidity increases. After the room temperature drops, the humidity also drops, and so on.

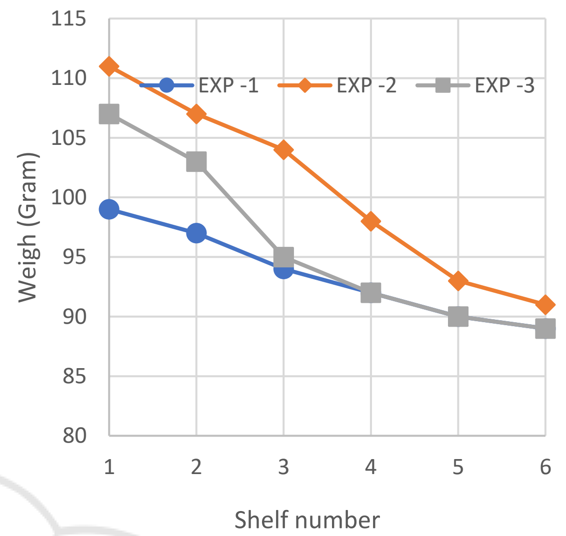

Figure 3: Weight of dry ginger after drying for each experiment and each shelf.

To make it easier to analyze the test results, the data in the table is made up of graphs.

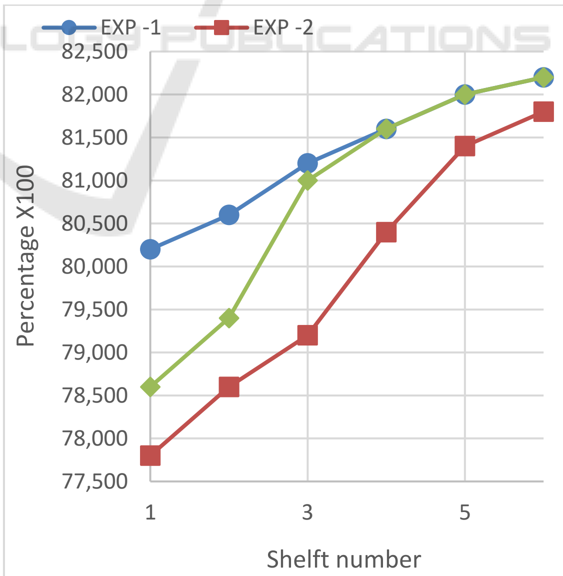

Figure 4: Percentage of weight reduction of fresh ginger for each experiment per shelf.

The process of the largest reduction in weight of ginger on shelf No. 6 each trial. As mentioned above, because rack number 6 has the highest temperature in the drying chamber. Likewise, the largest percentage of ginger weight reduction occurred on shelf number 6, as shown in Figure 4

Rack 6 is the lowest shelf, where under the shelf is the location of the electric heater, the temperature is the hottest, so with the highest temperature in the drying room, the weight of dry ginger occurs on rack number 6 for each test.

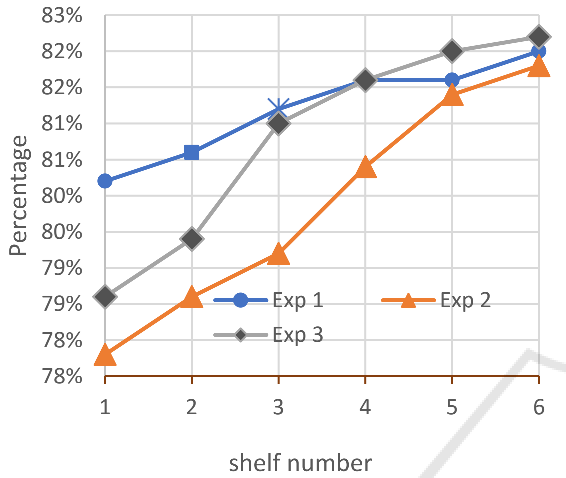

Figure 5: Graph of Percentage of Wet Weight Loss.

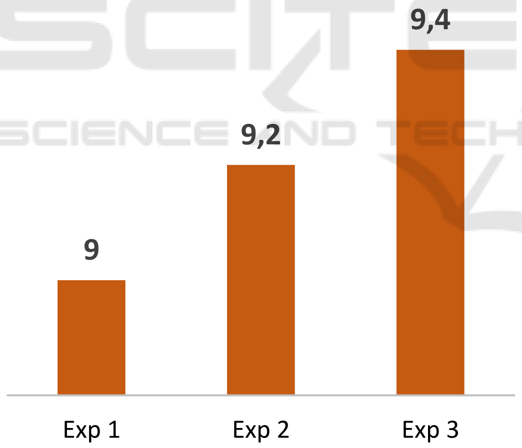

Figure 6: Water content of dry ginger after being made into ginger powder.

The dried ginger from the drying machine was removed, then crushed into ginger powder, then the water content was measured using a moisture meter. The result is test number 1, producing the smallest water content with a value of 9.

The average water vapor content of the results of the tests carried out was 9.2%. While the weight reduction of fresh ginger after drying reached 81%.

4 CONCLUSIONS

Machine made dryer, using ON/OFF control. The temperature in the drying room is controlled by a thermostat, controls the electric heater element, is set to 40 oC and the humidity in the drying room is controlled by Humiditystat, controls the refrigeration machine, humidity is set at 40%. The final result of the test to dry fresh ginger is the average moisture content of the results of the tests carried out is 9.2%. While the weight reduction of fresh ginger after drying reached 81%.

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