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TEMPERATURE AND RELATIVE HUMIDITY GAINS OF "TEKO BERSAYAP" MODEL SOLAR DRYER (A RESEARCH NOTE)

Yuwana, Bosman Sidebang and Evanila Silvia
Department of Agricultural Technology, Faculty of Agriculture, University of Bengkulu, Indonesia

ABSTRACT

In order to solve the problems arise from sun drying practices for agricultural products, a solar dryer was constructed having profile a jar in its long section and two wings appeared in its cross section. Whole structure was covered with UV plastic to harvest energy from the sun and the body of the jar was drying chamber, tunnel of the jar acts as chimney equipped with exhaust fan inside while the inclined wings function as added heat collector. The dryer was equipped with two inlets situated at the bottom ends of the wings. During operation fresh air entered into the inlets and was heated inside the drying chamber and was then exhausted through the chimney. Performance of the dryer was experimented for three times in three different days from 08.00 to 17.00 o'clock. The result of the experiment indicated that for the averages ambient temperature and relative humidity ranging from 29 to 38.7 ^oC and 41.7 to 68 % respectively, the averages drying chamber temperature and relative humidity were 32.4 to 51 ^oC and 18.6 to 53.8 % respectively. The average temperature gain which was the differences between drying chamber temperature and ambient temperature, and the average relative humidity gain which was difference between drying chamber relative humidity and ambient relative humidity were 10 ^oC and 21.4 % respectively.

Key words *: winged jar model, solar dryer, temperature gain, relative humidity gain*

INTRODUCTION

Water content of agricultural product plays important roles in enzymatic reactions during physiological process and in life cycles of microorganisms exist surrounding the products. Reducing water content to certain levels can inhibit, even stop enzymatic activity and the growth of microorganisms. Drying has been intensively employed to reduce water content of agricultural products. Open air sun drying was widely practiced in the world, especially in tropical regions. In one hand, this post harvest processing was simple, cheap and maybe economic. But in the other hand, this drying faces a lot of problems such as slow, space intensive, front to product damage and losses, time consuming especially during rainy season, risk of product contamination and thefts by animal and human.

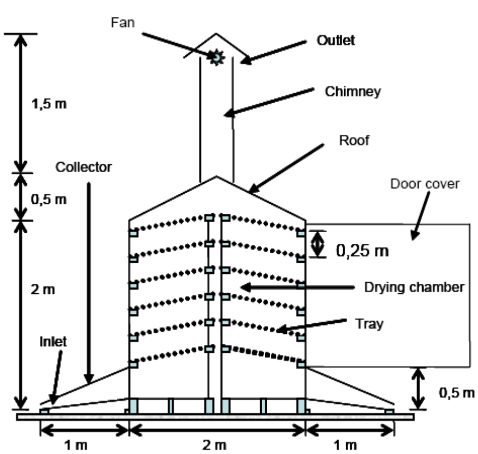
Efforts have been made to find out solution the above problems and various designs of solar dryer have been introduced (Soda et al., 1987). Based on the exploitation of energy coming from solar radiation and further application for drying agricultural products solar dryers can be classified as 1) hot-box type in which product is dried by the energy taking directly from the sun, 2) indirect type conventional dryers that heat product with solar energy heater, and 3) mixed type dryers in which product is dried by solar energy directly received from the sun and heat collected by solar collectors (Szulmayer, 1973; Lawand, 1980). In indirect mode type dryers, drying rate depends on design, size of collector and thickness of product layer to be dried. The first two factors will determine rate and quantity of energy supply while the last factor will be influenced by rate of drying air (Brooker et al., 1974), properties and shape of products being dried, product porosity

(Patterson et al., 1971), size of individual product (McLean, 1980) and product moisture content (Haque et al., 1982).

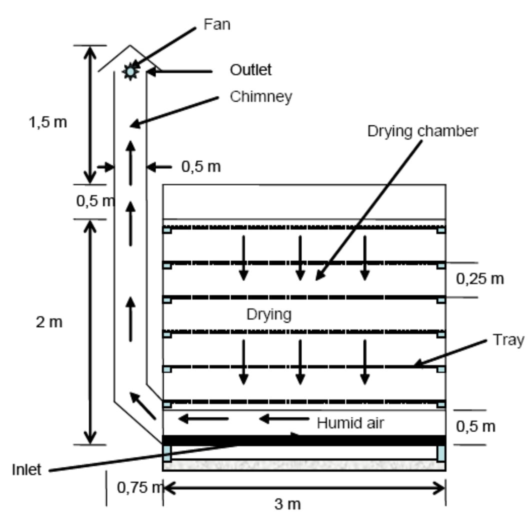
Within last decade some models of solar dryers have been developed and used for drying various agricultural products (Yuwana (1999); Yuwana, 2002, Yuwana & Mujiharjo 2004; Yuwana dan Mujiharjo, 2005; Yuwana, 2006; Yuwana, et al., 2008; Yuwana, 2009). This article presents the results of experiment on performance test of the winged jar model solar dryer with special objective to explore the temperature and relative humidity gains show by the dryer.

MATERIAL AND METHOD

The research objective was approached by designing the solar dryer (called winged jar model) and testing its performance without product inside. The dryer was constructed in Laboratory of Agricultural technology, Faculty of Agriculture, University of Bengkulu, Indonesia. The structure of dryer is presented schematically as Figure 1. It was made of a wooden frame covered with transparent UV plastic and whole structure occupied a total area of 4 x 3 cm2. Its important parts consisted of drying chamber, chimney, heat collectors and air inlets situated at the lower ends of the collectors. The flour of drying chamber was constructed from aluminum sheet painted in black and there were six pair of trays inside the chamber to place the product being dried. The size of each tray was 2.80 m x 0.85 m and made of threaded bamboo splits. An exhaust fan of 27 Watt was installed inside the chimney



(A)



(B)

Figure 1. Dryer structure (A : cross section, B : long section)

and the drying chamber was equipped with a door located at the opposite side of the chimney to load and unload the product to be dried.

The dryer was installed in open field and oriented across the sun. During operation ambient air entered in to the drying chamber from the inlets and was heated by solar energy captured by the structure and the heated the product placed on the trays. The humid air was exhausted out from the drying chamber by the fan. In this experiment the dryer was operated without loading the drying chamber (no product to be dried inside). The performance of the dryer was tested three times proposed as replications in three consecutive days from 08.00 to 17.00 o'clock. The parameters to be observed were the temperature and relative humidity of ambient air, the temperature and relative humidity of the drying chamber, and the temperature and relative humidity of air inside the chimney. Measurements were done by five hygrometers having temperature and relative humidity scales, placed one at the outside wall of the dryer, one in the chimney and three in the drying chamber (at the upper, lower and middle sides). In the case of the drying chamber, the values of temperatures and relative humidity were averaged as the representative values.

RESULTS AND DISCUSSION

Results of the experiment of three days performance test the dryer was presented in the form of graphs in function of time (o'clock). Figures 2, 3 and 4 show the temperature patterns of ambient, drying chamber and chimney for the first, second and third replication of the dryer performance tests.

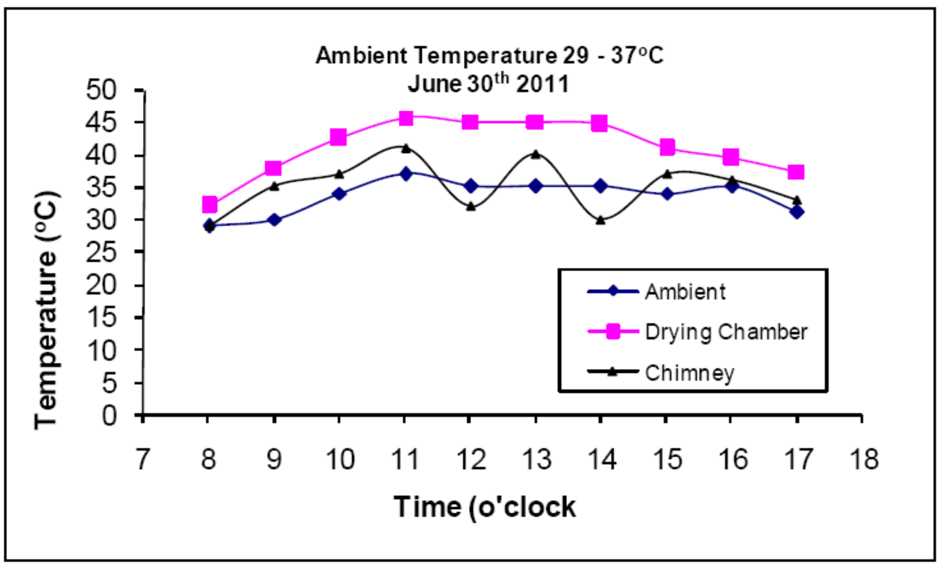


Figure 2. Temperature patterns of the first performance test

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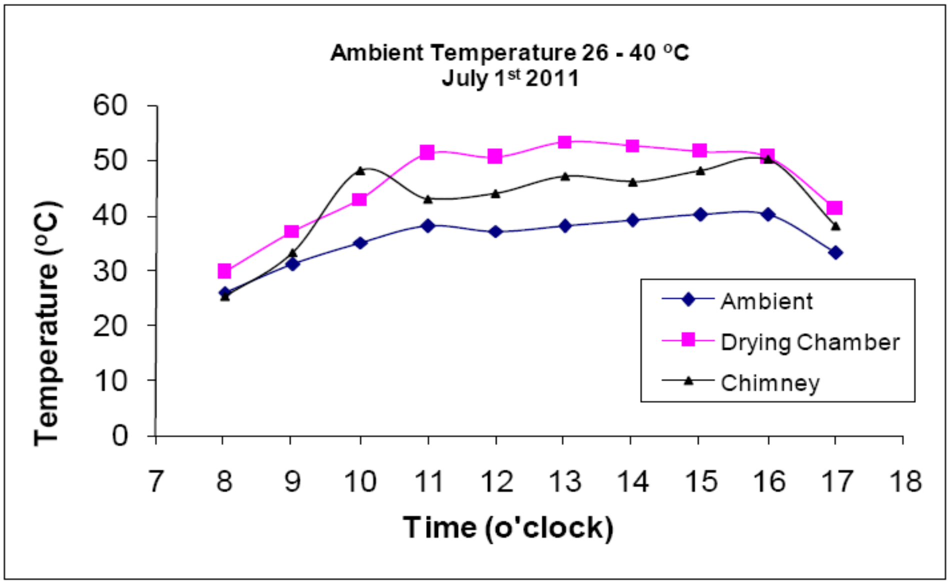

Figure 3. Temperature patterns of the second performance test

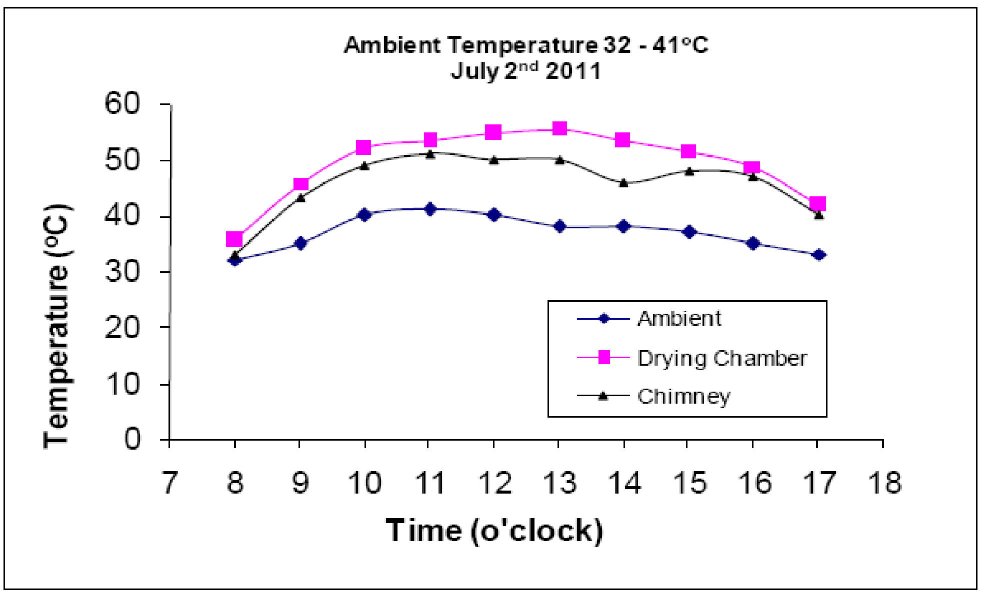

Figure 4. Temperature patterns of the third performance test

Calculation from these threes produced the average temperature of drying chamber of 32.4 to 51.2 oC for the average ambient temperature of 29 to 38.7 oC.

Figures 5, 6 and 7 present the relative humidity patterns of ambient, drying chamber and chimney for the first, second and third replication of the dryer performance tests.

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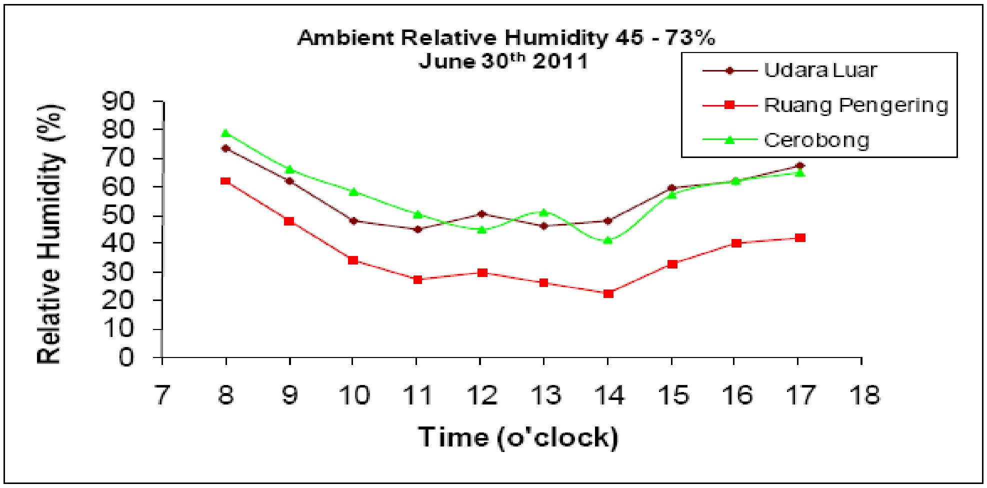

Figure 5. Relative humidity patterns of the first performance test

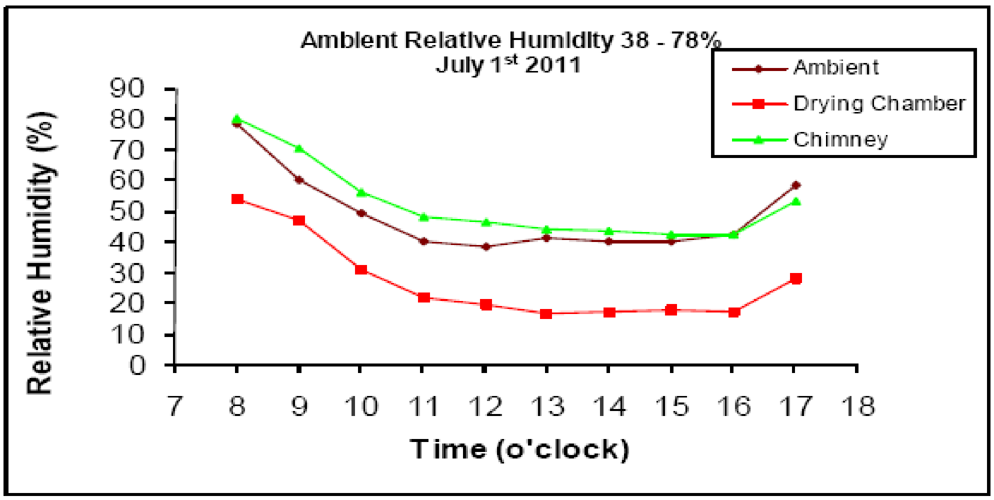

Figure 6. Relative humidity patterns of the second performance test

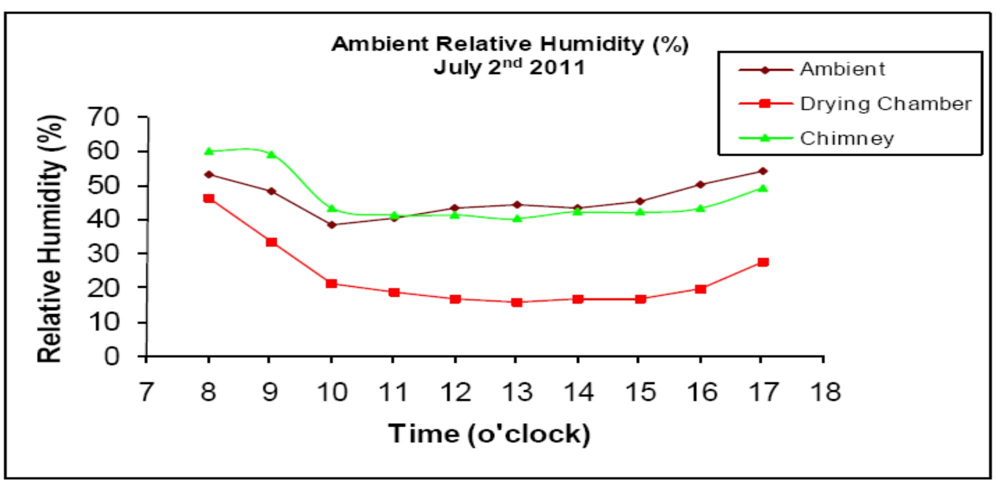

Figure 7. Relative humidity patterns of the third performance test

If values in these last three figures were averaged, gave the average relative humidity values ranging from 18.6 to 53.8 % for the average ambient relative humidity values of 41.7 to 68 %.

Subtracting the average values of temperature of drying chamber to the average values ambient temperature for the first, second and third performance tests generated average temperature gain pattern as shown in Figure 8 while average relative humidity gain pattern could be obtained from subtraction of the average values of ambient relative humidity to the average values of drying chamber relative humidity for the first, second and third performance tests as presented in Figure 9.

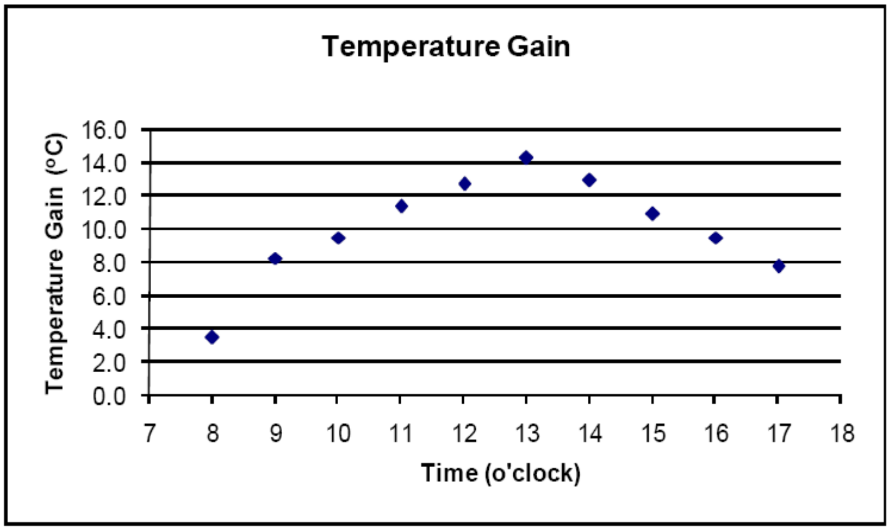

Figure 8. Average of temperature gain

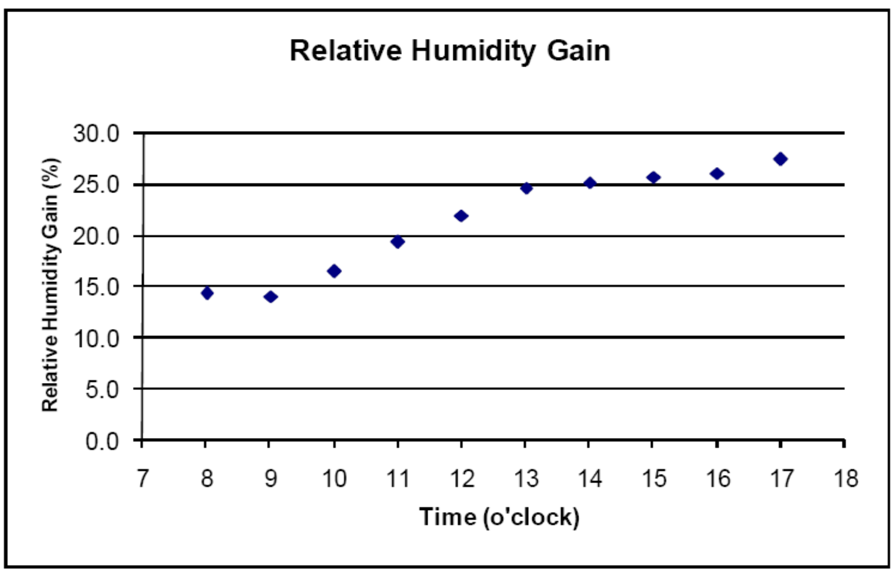

Figure 9. Average of relative humidity gain

If the average values of temperature gain and the average relative humidity gain were re-averaged Should result average of temperature and relative humidity gains 10 ^{o}C and 4.4 % respectively. It was also shown that the average temperature of chimney was 4.4 oC lower than that of drying chamber whereas the average relative humidity of chimney was 23.2 % higher than that of drying chamber. It was interesting to note that was able to conserve dry air until the sun set as shown in Figure 9.

CONCLUSION

Based the above results, it was concluded as follows. For the averages ambient temperature and relative humidity ranging from 29 to 38.7 oC and 41.7 to 68 % respectively, the averages drying chamber temperature and relative humidity were 32.4 to 51 oC and 18.6 to 53.8 % respectively. The average temperature gain and ambient relative humidity gain were 10 oC and 21.4 % respectively. The average temperature of chimney was 4.4 oC lower than that of drying chamber whereas the average relative humidity of chimney was 23.2 % higher than that of drying chamber.

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