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ALAT PENGERINGAN TENAGA SURYA "TEKO BERSAYAP" UNTUK PENGERINGAN IKAN

"TEKO BERSAYAP" MODEL SOLAR DRYER FOR FISH DRYING

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ABSTRACT

This objective of this research was to design a dryer called "Teko Bersayap" model and then to test its performance in drying fish in order to solve problems arising from open air sun drying. The dryer consisted of drying chamber with trays inside, heat collectors equipped with air inlets at their lower ends, chimney with an exhaust fan inside and humid air outlet at its upper end, was constructed to dry fish, "Bleberan (Pepetak Leiognatus spp)" species. The results of the experiment indicated that the dryer produced the drying chamber temperature 8.83^{o}C higher than the ambient temperature and the relative humidity 13.91% lower than the ambient relative humidity. The fish moisture content decreased exponentially with drying time and the dryer completed the fish drying process in 18.9 hours compared to 27.6 hours of drying time needed to complete the sun drying for the fish, suggesting that the dryer was ready for utilization

***Keywords** : "Teko bersayap" model solar dryer, drying performance, fish*

ABSTRAK

Tujuan dari penelitian ini adalah untuk merancang pengering model "Teko Bersayap" dan menguji kinerjanya dalam mengeringkan ikan. Alat pengering terdiri dari : ruang pengering yang berisi rak-rak pengering, kolektor panas dengan inlet udara di sisi bawahnya, cerobong dengan sebuah exhaust fan dan outlet uap air di sisi atasnya. Ala ini didesain untuk mengeringkan ikan "Bleberan (*Pepetak Leiognatus spp*)". Hasil penelitian menunjukkan suhu ruang pengering 8.83^{o}C lebih tinggi dibanding udara luar dan kelembaban udaranya 13.91% lebih rendah dibanding udara luar. Kadar air ikan kering menurun secara eksponensial dan waktu pengeringan mencapai 18.9 jam sedangkan ikan kering yang dikeringkan denga penjemuran membutuhkan waktu 27.6 jam.

Kata kunci : Pengering tenaga surya model "Teko bersayap", kinerja pengeringan, ikan

INTRODUCTION

Drying is a process of removing moisture from product by manipulating temperature or vapor pressure of the product (Henderson, *et al*., 1997). Open air sun drying has been widely conducted for fish in developing countries. It is practicable but some problems have been identified, such as slow in process, risk of product damages, losses and contamination (Shoda *et al.*, 1987). To solve the problems solar drying has been introduced and so many types of solar dryers have been developed (Szulmayer, 1973, Lawand, 1980). In term of performance, solar dryer depended on its design and thickness of product being dried. The design influenced energy supply while the thickness of product was determined by the rate of drying air (Brooker *et al.*, 1974), nature, shape and porosity of product (Patterson *et al.*, 1971), heterogeneity of size (McLean, 1980) and moisture content (Haque *et al.*, 1982).

Yuwana (1999) and Yuwana (2002) developed green house effect solar dryer which consisted of wooden frame, heat collector made of aluminum painted in black, drying chamber equipped with trays, heat storage and chimney. This dryer worked by trapping as much as solar energy and then made of this energy to heat the wet product situated on the trays in order to evaporate its moisture content. This dryer produced temperature of drying chamber 37.8 – 55.8^{o}C (2-21^{o}C higher than ambient temperature) and was able to decrease the moisture content of fish from 76,44% to 14.18% within 15 hours. The dryer had been modified and experimented for some commodities. The results of experiments indicated that the dryer completed drying of banana and rice cracker in 2-3 days (Yuwana and Mujiharjo, 2004), drying of banana slices in 1-3 days (Yuwana and Mujiharjo, 2005), fish crispy in 1-2 days (Yuwana, 2006), mustard greens in 2 times faster than that's of sun drying (Yuwana, *et al*., 2008).

This article presents the results of experiment on testing the last modified model called "Teko Bersayap" for fish drying.

METODOLOGY

The research consisted of equipment design, drying experiment, data processing and analysis. The dryer was constructed in Laboratory of Agricultural Technology, Department of Agricultural Technology, Faculty of Agriculture, University of Bengkulu, Indonesia. This whole structured was made of wooden frame covered with 14% UV transparent plastic and occupied 4 x 3 m^2 total area. The important parts of this dryer were drying chamber, chimney and 2 heat collector (1 right wing, 1 left wing). The drying chamber was equipped with 12 trays (6 for right wing, 6 for left wing) measured 2.80 m x 0.85 m each to put fresh fish being dried. The trays were made of wooden frame with plaited bamboo splits to improve hot air circulation in the drying chamber. The dimension of chimney was 0.5 m x 0.5 m x 4 m with 30 Watt suction fan inside situated at the its lower end which accelerated the expulsion of humid air from the drying chamber. The heat collector was designed from woven aluminum painted in black and was placed on wooden board. It was also covered with 14% UV transparent plastic and complemented by air inlet at its lower end. The collector absorbed solar energy penetrated the transparent plastic and then the energy heated the incoming fresh air from the inlet. The heated air entered the drying chamber and acted as main source energy supply of the dryer. The doors of drying chamber were situated at its wall at the opposite side of the chimney and it functioned to upload and download the trays.

The dryer operated as follows. As the sun rays approached the structure, it accumulated entering solar energy to heat air in the drying chamber. Hot air having lower vapor pressure than ambient air created pressure gradient within the structure and caused ambient air to enter the inlets. The entering air was heated by absorbed energy in the collector and then passed through the drying chamber and then left the structure from the outlet of chimney. This situation created hot air circulation from the inlets to the outlets and drying process occurred.

The experiments used "Bleberan (*Pepetak Leiognatus spp*)" fish species having averages length, width and thickness of 12 to15 cms, 3 to 5 cms and 1.3 to 1.8 cms respectively. During experiments the fish samples were loaded on the trays and the full capacity of dryer was about 100 kgs. The variables observed of the experiments were drying chamber, chimney and ambient temperatures, drying chamber, chimney and ambient relative humidities, and fish moisture contents by weighing the samples. The temperatures and relative humidies were measured by installing thermo-hygrometers at 3 point in the drying camber (on the tray 2, 4 and 6), inside the chimney and outside the dryer while the fish moisture contents were determined by periodically weighing 20 fishes for every tray using an analytical balance along the drying process. In the end of drying processes, the samples of fish were taken to the laboratory to be determined their moisture contents.

The drying experiments were conducted in three runs in July and August 2012, and the results were presented in the form of graphs, moisture contents in function of drying times. As comparison sun drying was also done in which the preparation of samples, observation variables and the determination of moisture content were carried out in the same method that's of solar drying experiment.

RESULT AND DISCUSSION

The observed drying chamber and ambient temperatures, and drying chamber and ambient relative humidities were presented in Figure 1 and 2. The experimental data also indicated that the averages drying chamber and ambient temperatures together with its deviation standards were 40.54 (±1.94)^{o}C and 31.71(±0.87)^{o}C respectively, and the averages drying chamber and ambient relative humidities together with its deviation standards were 53.84 (±4.8)% and 67.75 (±3.44)% respectively so that the dryer was able to generate the drying chamber temperature 8.83^{o}C higher than the ambient temperature and the drying chamber relative humidity 13.91% lower than the ambient relative humidity. To justify the performance of the dryer, the temperature and relative humidity ganis can be compared to the vaules reported by other researchers. The temperature gain (8.83^{o}C) was higher than the temperature gain of Doe solar tent (6.2^{o}C) reported by Olokor and Omojowo (2009) and the temperature gain of the passive solar dryer (8^{o}C) reported by Dasin *et al*. (2015). The relative humidity gain (13.91%) was also higher than the humidity gain of Doe solar tent (7.2%).

Figure 3 indicates the relationship between fish moisture content and drying time. The fish moisture content decreased exponentially with drying time. This tipical of curve was also found by Sablani *et al*. (2003) in Sardines fish drying by the solar dryer and by Swati and Chauhan (2015) in salted and unsalted Croaker fish drying and Anchovy fish and Ribbon fish drying by the greenhouse solar tunnel.

If the fish was justified to be dry when its moisture content reached 20% wet basis (wb) (Anonym, 2009), the solar dryer completed the drying process in 18.9 hours which was 8.7 hours faster than the sun

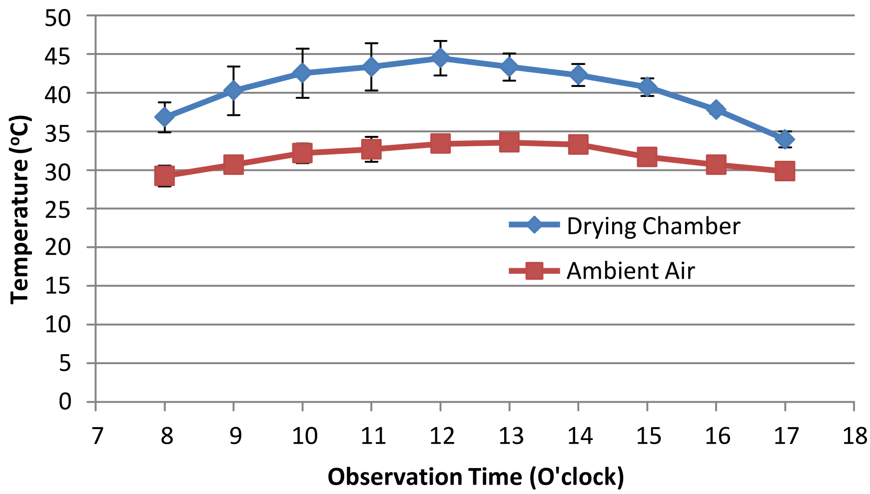

Figure 1. Fluctuation of Drying Chamber and Ambient Temperatures during Drying

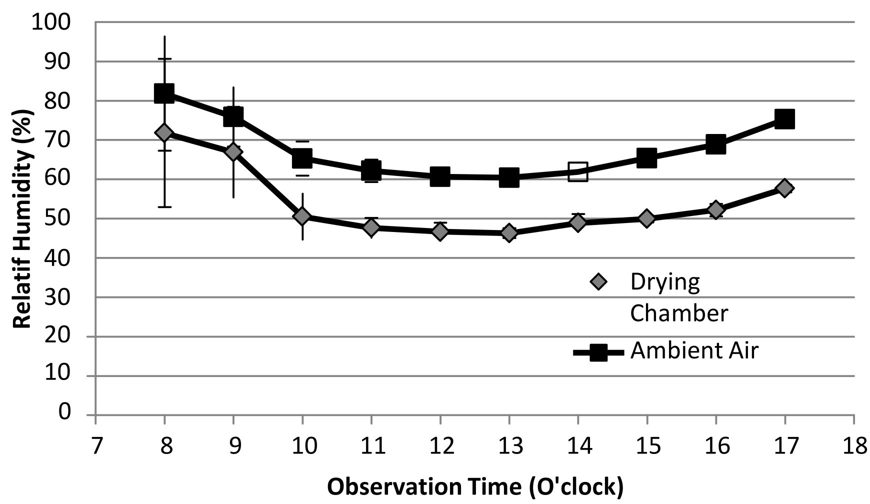

Figure 2. Fluctuation of Drying Chamber and Ambient Relative Humidities during Drying

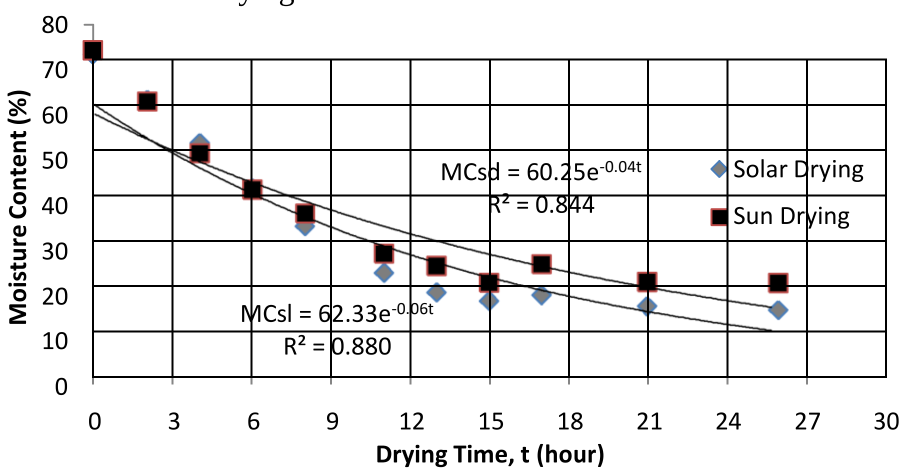

Figure 3. Relationship between Fish Moisture Content and Drying Time

drying (27.6 hours). The performance of this dryer was better than that of a multi racks dome dryer found by Sablani *et al*. (2003) since this dryer consisted six story racks and completed drying process faster than sun drying in contrast the multi racks dome dyer had only three stories and performed similar to the open rack they reported. Furthermore this dryer also performed better than greenhouse solar tunnel dryer reported by Swati and Chauhan (2015) that operated with drying temperatures from 40^{o}C to 45^{o}C and reduced moisture contents of unsalted fish from 226,95% - 296.05% (db) to 17.64 % - 25 % (db) in 24 to 32 hours depending on the variety of fish and their initial moisture contents.

CONCLUSION

It can be concluded that operating in dry season, the dryer was able to generate the drying chamber temperature 8.83^{o}C higher than the ambient temperature and the relative humidity 13.91% lower than the ambient relative humidity. The fish moisture content decreased exponentially with drying time and the dryer completed the fish drying process in 18.9 hours compared to 27.6 hours of drying time needed to complete the sun drying for the fish. This finding suggested that the dryer was ready to be adopted for application.

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