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WORKING PRODUCTIVITY ANALYSIS ON THE PROCESS OF DRYING FISH USING SOLAR DRYERS

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Abstract. The process of drying fish using solar energy is strongly influenced by weather conditions. Sunlight is needed by household scale workers because it is cheap. On the other hand, sun drying creates additional workload for workers. Workers are exposed to hot sun during drying. Continuous heat exposure results in an increased work pulse. This affects the level of worker productivity. To anticipate this, a solar dryer is used by utilizing a solar collector as an absorber of sunlight and a drying chamber for the drying process of fish. The use of solar dryers has been shown to increase drying temperatures and reduce workers' sun exposure. This decreases the workload of workers, so that it has an impact on increasing productivity. Worker productivity increased by 133.94%.

Keywords : solar energy, productivity, solar collector.

1. INTRODUCTION

Indonesia as a tropical country, rural population uses the sun as a source of food preservation. The drying process is carried out for post-harvest handling so that food quality is maintained properly. Sun drying is drying directly in the sun. This affects the need for a large drying area, the product is less hygienic because it is susceptible to animal disturbance and dust, the temperature and drying time are less than optimal. The alternative is to optimize the sun as a source of drying energy through a dryer with a solar collector.

The solar dryer makes use of a flat plate collector for sun absorption so that the ambient air heats up faster. In general, drying can be done through sun drying, namely the product to be dried directly in the sun and drying with a solar dryer, namely the product to be dried is placed in a drying chamber [1]. Sun drying takes a long time and the temperature is not optimal. Sun drying to dry anchovies, which is done when the weather is sunny, takes two days with a drying temperature of ±33.43ºC [2]. Research on the drying process to handle post-harvest both in plantations and fisheries has been widely carried out. The use of computational fluid dynamic (CFD) software to evaluate the drying of the pepper with a solar collector and chimney design obtained a drying room temperature between 335.4 - 352 K [3]. The use of a drying room for the drying process has an impact on increasing worker comfort. The drying process of fish using a drying chamber which is designed based on ergonomic principles can reduce the musculoskeletal complaints of workers by 26.70% [4]. To increase the drying temperature using solar energy sources is done by using a solar collector application. The plates on the collector will absorb sunlight so that the environmental air heating is more optimal. This hot air is flowed into the drying chamber and used to dry food. The use of solar collectors can increase the temperature of the drying chamber. The temperature in the drying chamber is the most important parameter affecting the drying rate directly [5]. The absorption of solar energy is optimized using a flat plate collector by adding an absorber in the form of granite [6].

Dryers with solar collectors called solar dryers are used for the drying process of anchovy on a household scale. Drying is done to preserve the anchovies. Anchovies undergo a fast process of decay due to the high water and nutrient content, so it is easy for bacteria to grow and due to chemical changes in dead fish. To avoid the decay process, preservation is carried out to reduce the water content in the fish. This is so that bacteria do not reproduce. Fish in general have a content varies between 50% -80% [7]. Dried anchovy contains about 33.4% protein and 3% fat only [8]. The drying process with the solar dryer system provides better display quality and nutritional content, and the color of the fish looks cleaner. This has an impact on the productivity level of workers as processors of dried anchovy.

The use of solar dryers in drying fish can reduce the workload of workers. Reduced workload will increase productivity levels. The level of worker productivity is influenced by the workload [9]. Workload arises as a result of physical and mental activity, which is indicated by a change in pulse frequency. The higher the body activity is directly proportional to the higher the pulse frequency [10]. To increase the productivity of workers doing anchovies drying business, use solar dryers. A dryer with a solar collector will convert sunlight to thermal.

2. METHODS

This study used anchovies as a sample. The test is done by comparing the drying process between solar dryers and drying them in the sun. The solar dryer consists of a flat plate type solar collector, a drying chamber with additional shelves inside. The energy source uses the sun. Collector surface area of 1,045 m^2 with absorbent using 1.2 mm aluminum plate painted black with 5 mm clear glass covering material, 1 layer. The area of each shelf in the drying chamber is 0.7505 m^2. The shelf material in the drying chamber is bamboo. Productivity is calculated based on Equation 1.

$$P = \frac{O}{I\,x\,t} \quad (1)$$

P = work productivity (kg / hr.ppm or kg / min.ppm); O = output in the form of dry anchovy weight (kg); I = input in the form of workload calculated based on work pulse (ppm); and t = length of time worked (hours).

The productivity level is calculated for each worker during the drying process using a solar dryer and drying in the sun as shown in Figure 1.

(a) (b)

Figure 1. Drying anchovies a) solar dryer, b) drying in the sun

3. RESULTS AND DISCUSSION

The drying process using solar dryers can increase worker productivity when compared to drying in the sun. This can be seen from the shorter drying times and decreasing workloads. The solar dryer requires an average fish drying time of 6.21 hours. Meanwhile, drying in the sun requires an average drying time of 12.71 hours. Drying time in sunny weather conditions for both treatments. The average sun drying temperature is 35.47°C and the average drying chamber temperature in the use of a solar collector is 47.13°C. The drying process for both treatments was carried out from 09.00 to 15.00. The temperature of the drying chamber with a load of 20 kg of fish of 47.13°C meets the applicable temperature requirements for drying fish. This is in accordance with [7] that the drying temperature for fish is 40-50°C, if the temperature exceeds 50°C it affects the outside of the dry product but the inside is still wet. The drying temperature ratio is as shown in Figure 2.

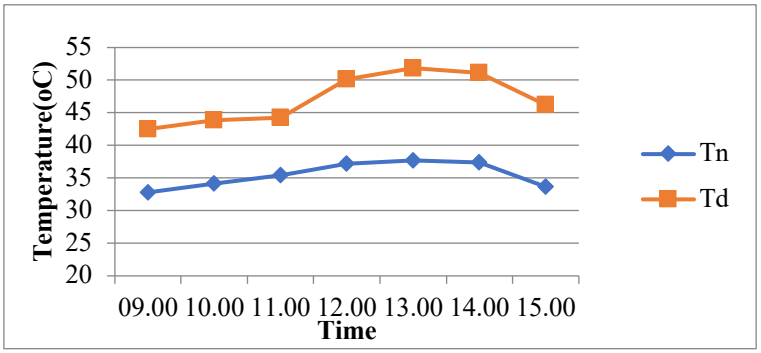

Figure 2. Drying temperature using a solar dryer (Td) and sun drying (Tn)

The drying process using a solar dryer is able to reduce the workload which is calculated based on the pulse of workers from 104.84 pulses per minute (ppm) to 91.22 ppm. This is as a result of the shorter working time on the use of solar dryers. Based on the working time and workload, the work productivity of the fish artisan is obtained as shown in Figure 3.

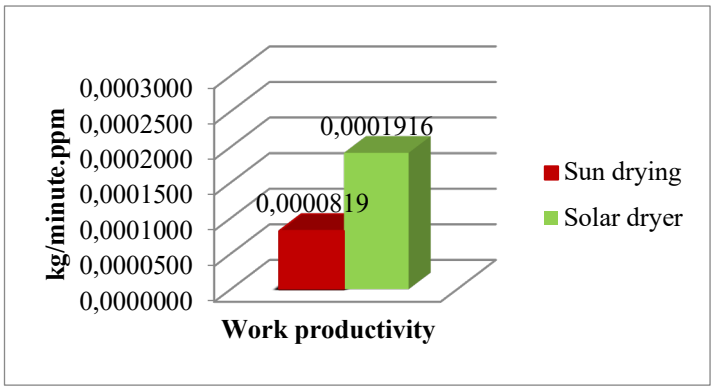

Figure 3. Physiological work productivity of fish artisan

Worker productivity has increased by 133.94%, from 0.0000819 kg/minute.ppm to 0.0001916 kg/minute.ppm. Productivity is affected by the workload which is calculated based on the work pulse. The comparison of the work pulse of the fish artisan between sun drying and using a solar dryer is shown in Figure 4.

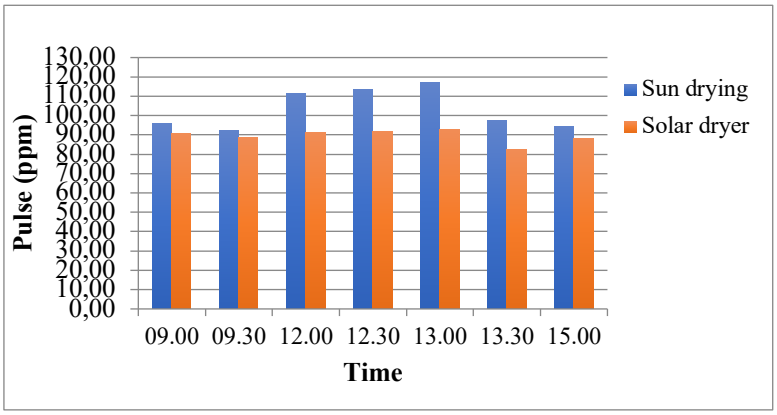

Figure 4. Pulse distribution of workers when drying fish

When drying workers in the sun, they have a higher pulse when compared to using solar dryers. Solar dryers for the fish drying process provide a more efficient way of working for workers. More efficient work is proven to increase worker productivity and has implications for improving worker welfare. Exposure to the sun's heat will affect the emotional level of workers as indicated by an increase in the workers' pulse. This condition will affect worker productivity. This is in line with [11] who tested the effect of emotions on work productivity. It was explained that productivity refers to the efficiency of workers producing products to achieve goals in the business. In addition, increasing productivity is an important consideration for overall well-being.

4. CONCLUSION

Productivity is an important consideration for the welfare of workers. In this study, the measurement of productivity based on the workload of workers is to use the work pulse. The workload has decreased after using the solar dryer for drying fish. This has implications for increasing worker productivity. Productivity increased by 133.94%. Productivity measured based on workload indicates that workers doing work is more comfortable and efficient.

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