Fish drying machine with PV system for fisherman to support blue economy

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ABSTRACT

The abundance of fish catches in Indonesia is excellent potential. Still, if the abundant results cannot be adequately managed and are just wasted, it will eventually lead to bad things. This problem was also found in Seraya Village, Karangasem, Bali, where large fish yields and the fish processing process were still constrained by weather and environmental conditions causing the expected results to not be achieved. To overcome this, a photovoltaic (PV) system-based fish dryer was developed that can assist the fish drying process. Utilization of this system is also supported by good solar energy potential. The system can generate 402.78 Wh of electrical energy per day, covering 104.89% of the electrical energy demand of the fish dryer. The results of statistical tests using the Mann-Whitney test for fish weight and unpaired t-test for fish moisture content showed no significant results (p>0.05). This value states that there is no difference in the results of drying fish with the PV system and the traditional method. From this, we can conclude that fish drying using a solar power system works similarly to conventional fish drying methods.

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1. INTRODUCTION

Indonesia is one of the countries with a large enough production of fishery products in the world [1]–[4]. These production results are obtained from fishing activities or fish cultivation that are caught or harvested from natural fishery sources or from maintenance sites, both those cultivated by fishing companies and fishing households. This result is supported by the vast waters owned by Indonesia. Based on data from the Ministry of Marine Affairs and Fisheries Republic of Indonesia in 2019, the results obtained reached IDR 204 trillion with a total catch of 7,164 megatons.

Many people consume fish because of its protein source, low price, and easy access to fish [3], [5]–[7]. Despite these benefits, seafood is a perishable commodity. This problem requires a fast and precise handling process to maintain its quality before it is placed on the market and in the hands of consumers [6], [8]. Therefore, preservation processes are necessary to extend the shelf life of fish [9].

Processing and preservation is an attempt to improve the quality of post-harvest storage and shelf life of seafood [9], [10]. The aim of this activity is, in principle, to overcome overproduction while preserving the quality of the fish before it is placed on the market or before it is consumed, increasing the marketability of fish as a food diversification ingredient and extending the shelf life [11]–[15]. Fish processing and preservation is an important part of the fishing chain. Without these two processes, the increase in fish production achieved so far would be wasted. Fish preservation aims to reduce the water content of fish so that bacteria cannot grow [8], [9], [12], [14]. Good and high-quality preservation results require proper handling during the preservation process, such as tools used, maintain cleanliness of materials, and use fresh fish. There are many different types of fish preservation processes, such as salting, drying, impregnating, fermenting, and refrigerating the fish [16]–[19].

Indonesian fishermen perform a traditional process of drying fish using direct sunlight. Drying using this method is usually done by placing fish products on fishing nets, mats, floor mats, or woven bamboo and placing them in the sun [20]–[23]. This method is unsanitary and supports products that have lost weight due to insect, bird, cat and other animal losses. Also, the product is susceptible to dust and the drying process is maintained even when it rains, so the expected results are not optimal and the yield is not reasonable. These conditions led to the idea of designing and manufacturing a hybrid fish dryer that uses energy from the greenhouse effect. The fish drying plant is made using solar energy to assist the fish drying process. Very good solar energy potential in Indonesia is the only reason to use this energy [24]. The tool we created will also integrate with internet of things (IoT) to make it easier to see the condition of the fish [25]–[32].

This study aims to determine the capacity of the tool and support blue economy policies in the process of drying fish according to the guidelines of the Ministry of Marine Affairs and Fisheries [25], [33]–[36]. The system will also be an introduction to fishermen who still scrape small fish in some parts of Indonesia. The potential of fish is very large, and it is very likely that it will be developed as an activity to revitalize the economy of fishermen.

According to the confessions of fishermen interviewed in Bali and the East Nusa Tenggara area, few people have witnessed the drying of fish. The presence of fish dryers can help deal with surplus fish products by leveraging solar energy technology and facilitating the monitoring process with IoT. This fish dryer does not depend on the weather, so the drying process takes less time and maintains the hygienic quality of the fish.

2. METHOD

The fish drying machine experiment was carried out for 7 days in Seraya Village, Karangasem Regency, Bali. This location was chosen because the catch of fish obtained by the fishermen is quite large, but there is still a lack of further processing. Therefore, the designed fish dryer was tried to be applied by fishermen and tried to find out the fishermen's response to the use of this technology.

In the process of using this photovoltaic (PV)-based fish dryer, fishermen are given a try to compare traditional fish processing methods and use this technology. This test includes the drying process of fish consisting of fish moisture content, initial fish mass and final fish mass. After the test results are obtained then proceed to the next analysis.

Association tests are used to discover and find relationships between variables in studies. In this study, relationship (relevance) is performed by comparison test. The comparison test performed is an unpaired comparison of two groups because it comes from two different groups of data (fish that are dried using tools and traditionally dried).

Before conducting the comparative test, the normality test was conducted. This test was conducted to determine the normality of the data distribution, by looking at the results of the Shapiro-Wilk test. The Shapiro-Wilk test was chosen because the number of samples was less than 50. If the data obtained were normally distributed, $p>0.05$, then the comparative hypothesis test was carried out using an unpaired t-test (parametric test). If not, then the Mann-Whitney test (nonparametric test) will be used.

The results of the analysis of the comparative test will be obtained p value. The results of the comparative test analysis are given as p-values. Then use p-values to test hypotheses to make inferences about relationships between variables or to indicate whether there is a relationship between variables. If the p-value is <0.05, the means of the two data groups are significantly different. Before carrying out the comparative test, the data from the measurement results were tested for validity with the pearson bivariate test and reliability with the Cronbach's alpha test. Flow chart for statistical analysis can be seen in Figure 1.

This research will also provide an overview of the use of PV systems as a source of electrical energy for fish drying machine. The system designed will provide an overview of the energy generated by the need for electrical energy in the process of drying fish. The electrical energy produced by the PV system is obtained by measuring the output voltage and electric current generated by the solar panels. The results of these measurements are then calculated and the output of electrical energy per day will be obtained [24].

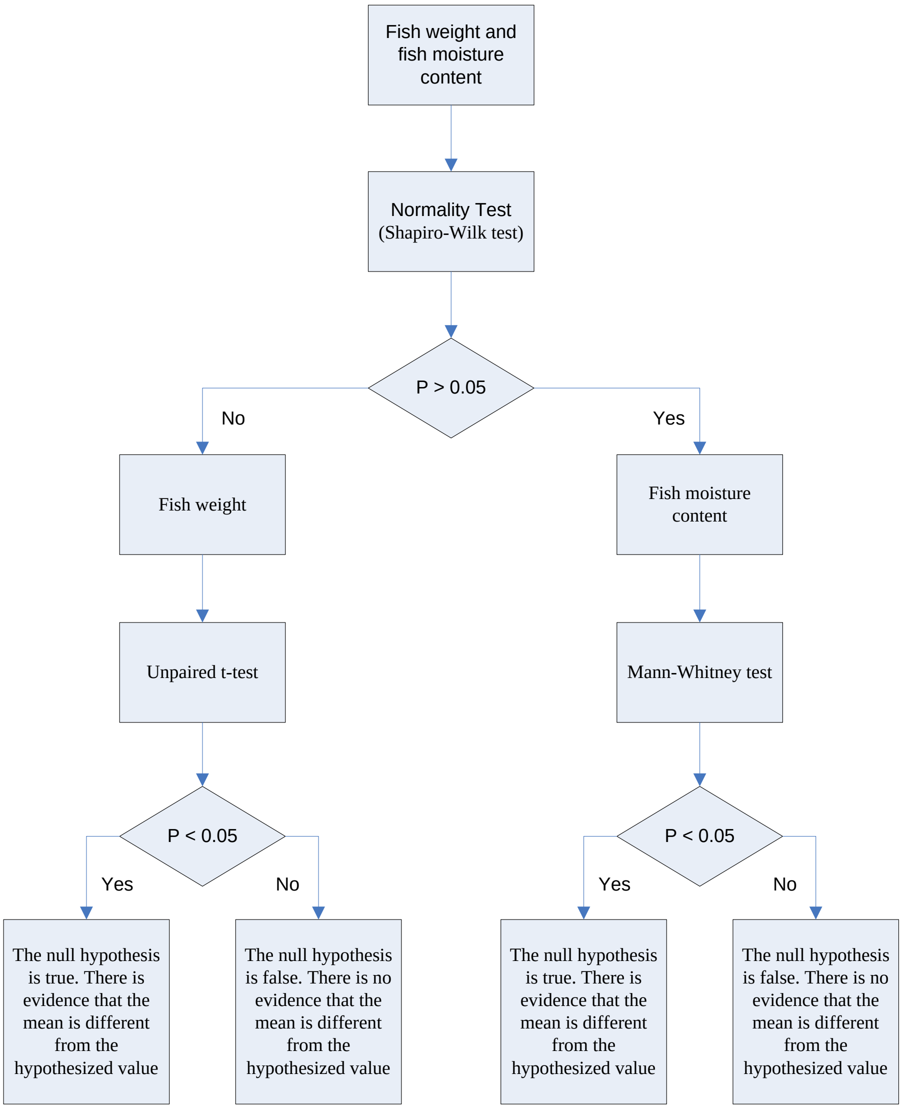

Figure 1. Statistical test of utilization fish drying machine

3. RESULTS AND DISCUSSION

3.1. Fish drying machine test

The use of a PV-based fish dryer for 7 days in Seraya Village, Karangasem, Bali, can generate an average of 402.78 Wh/day of electrical energy. The maximum energy harvested is 457.30 Wh and a minimum of 330.65 Wh. Differences in the output produced are caused by environmental factors, such as wind speed, humidity and temperature (Table 1 and Figure 2). This fish dryer uses power from a 100 Wp solar panel and a 12 V 65 Ah battery, and uses a buck converter to reduce it to 4.9 V DC (Figure 3). This PV system can fulfill 104.89% of the electricity demand of 384 Wh/day from the drying system. The electrical load for this system is supplied by a 5 W control system and 10 W UV lamp.

Table 1. Environmental conditions in Seraya Village

Day	Temperature (ºC)	Wind speed (m/s)	Humidity (%)
1	26.9	2.95	19.35
2	26.9	2.49	18.92
3	27	2.73	18.49
4	27	2.57	18.49
5	27	2.43	18.98
6	26.9	3.3	18.8
7	26.6	2.99	18.62

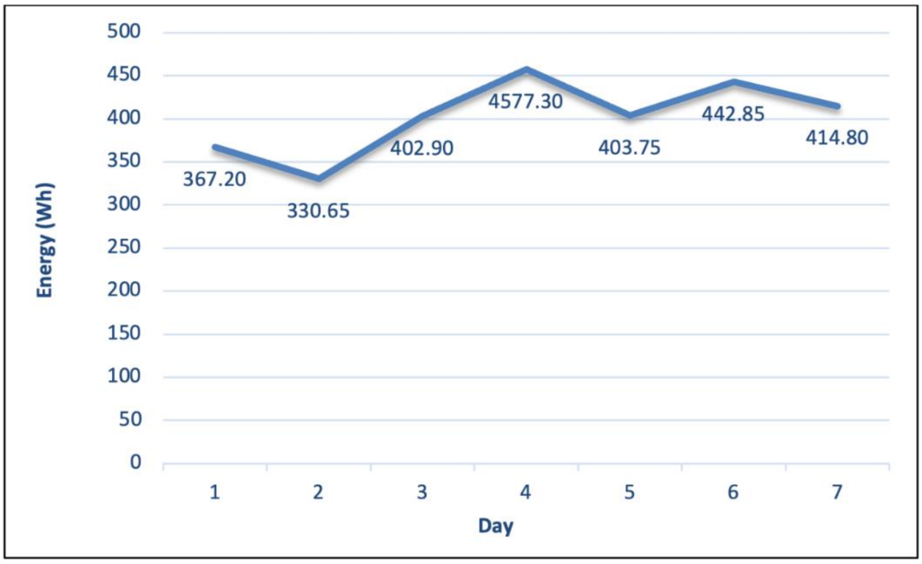

Figure 2. Energy output from the PV system

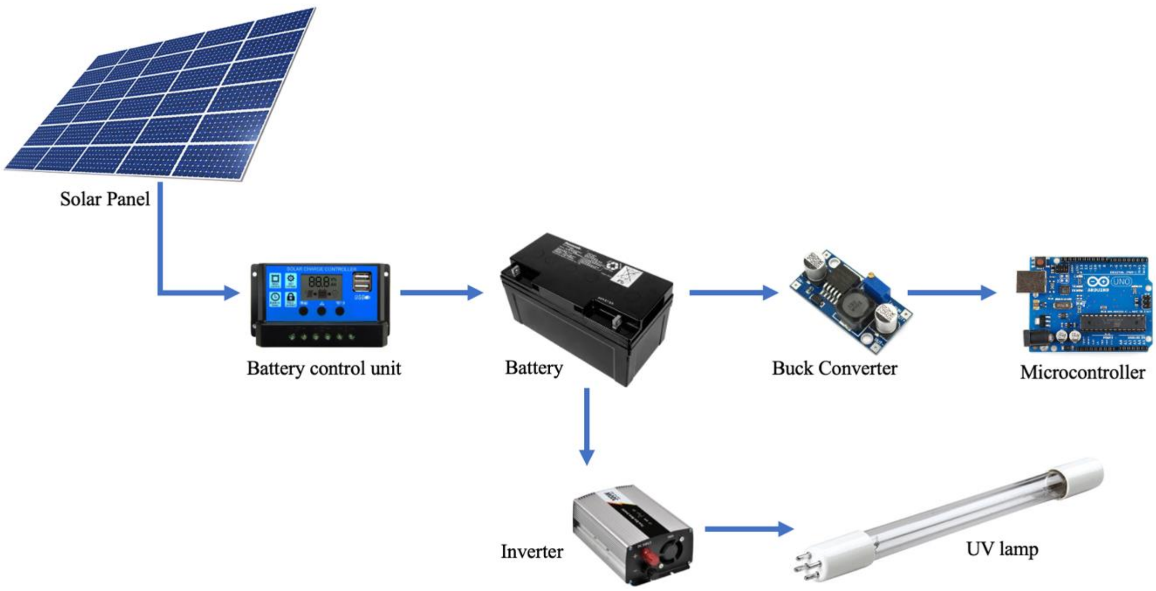

Figure 3. Fish drying machine with PV system

3.2. Fish drying process test

Tests for fish drying were carried out by comparing fish dried using the PV system and fish dried traditionally. From the test results obtained data including fish weight and fish water content. The two data were then collected and then tested for validity, reliability, and comparative.

The results of the validity test with the pearson bivaritate and the reliability test with the Cronbach's alpha test obtained valid and reliable results. The test results show that the Pearson Bivaritate shows the value of r count >0.05, so it can be stated that the measurement results have a significant correlation with the total score (valid). The results of the Cronbach's alpha test show the result of 5.21, it can be stated that the reliability is moderate.

The results of data normality showed that the data for fish weight were not normally distributed ($p<0.05$), while for fish water content the data were normally distributed. Based on the results of the normality test of the data, the comparative test for fish weight will be tested by the Mann-Whitney test (nonparametric test), while for the water content of the fish it will be tested using the unpaired t-test. The results of the comparative test can be seen in the Table 2.

The results of the Mann-Whitney test for fish weight between fish dried using the PV system and the traditional method were not significant (p>0.05). This value states that there is no difference in the results of drying fish with the PV system and the traditional method (Table 2). So it can be concluded that the fish dryer using a PV system can work well as well as the traditional fish drying method.

The results of the unpaired t-test for fish moisture content between fish dried using the PV system and the traditional method were not significant (p>0.05). This value states that there is no difference in the results of drying fish with the PV system and the traditional method (Table 3). So it can be concluded that the fish dryer using a PV system can work well as well as the traditional fish drying method. In addition to providing results that are no different from traditional methods, drying fish using a PV system also provides cleaner, animal-safe, and hygienic results. This is because the dried fish condition is maintained in such a way in the fish dryer.

Table 2. The results of the Mann-Whitney test of fish weight between using PV and using the traditional method

Respondent groups	n	Median (minimum-maximun)	Mean±S.D	p
PV system	8	309 (236.53–416.61)	320±90.57	0.752
Traditional method	8	352 (300-414)	355.33±57.07	

Table 3. The results of the unpaired t-test of fish moisture content between using PV and using the traditional method

Respondent groups	n	Median (minimum-maximun)	Mean±S.D	p
PV system	3	41 (26-48)	38.53±11.50	0.866
Traditional method	3	30 (22-46)	32.87±12.55	

4. CONCLUSION

A fish dryer with a PV system can supply 402.78 Wh of electricity per day, with a dryer load requirement of 384 Wh per day. This PV system can supply 104.89% of the electrical energy needs of the machine. The results of statistical tests with Mann-Whitney for fish weight and unpaired t-test for fish moisture content showed no significant results (p>0.05). This value states that there is no difference in the results of drying fish with the PV system and the traditional method. So it can be said that the fish drying device using the PV system can work well as well as the traditional way of drying fish. The use of this system is also expected to support the Blue Economy policies implemented in Indonesia.

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