Evaluation of Power Consumption in Moringa Leaves Dryer

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Abstract: Moringa leaf dryer using solar collector and PLN electricity results from developing renewable energy that utilizes solar energy directly or indirectly and combines it with PLN electricity. The aim is to increase the production of dried Moringa leaves with tools designed to produce quality and hygienic for consumption, reduce dependence on weather. Another point is to minimize losses experienced by Moringa farmers at harvest, minimize the possibility of damage caused by decay, accelerate the Moringa processing process, and do not require a large land area. Two ways are done in the moringa leaves' drying process: 1) Direct sunlight hits the glass collector. Heat is collected in the collector's room and distributed in the dryer room using additional tools such as *fans* or *blowers* needed to drain the dryer air to the Moringa leaves to be dried (forced convection) and use the temperature sensor as a temperature controller in the room. Drying process. 2). The oven works by utilizing PLN electricity for drying done at night. And the expected dryer temperature is 37-40^0C for three days. The process of setting the temperature control in the room of the moringa leaf dryer using TNZ4H control temperature connected with the RTD sensor by selecting the setpoint 35-45 ºC. If the temperature is less than 35 ºC, the heat source (Lamp) will turn on if more than 45 ºC, then the lamp will go out. The drying result of 20 kilos of moringa leaves only takes about 8 hours with the average temperature in the dryer room 40ºC. While with a weight of 100 kilos takes about three days because the drying process still requires the sun as a source of heat and backup power. The average temperature in the rack during the drying process of Moringa leaves weighing 100 kilos is 37ºC. The maximum temperature in the moringa leaf dryer is 61.1ºC, with a maximum outside temperature of 42ºC. So it is necessary to analyse the calculation of the amount of power, and the cost of electricity consumption is proper and efficient for moringa leaf dryer. From the results of this calculation, the tool can be produced and utilized by the community.

1 INTRODUCTION

The use of Moringa for the people of NTT Province is very potential and diverse, both from food processing businesses, medicines, etc. Moreover, Moringa plants are easy to grow, thrive in tropical climates such as the NTT region, and do not require extra care, making Moringa a prima donna plant in NTT.

The processing itself is not so tricky only requires full accompaniment to produce Moringa with good quality. But there are some obstacles related to the drying process that is the drying process done by moringa farmers by utilising direct sunlight. First, the dry season is not an obstacle, but the rainy season, where the sun is not shining too well and often cloudy, will hinder the drying process to the maximum. The second problem in marketing is that drying Moringa leaves that are not optimal will cause a decrease in the income of Moringa farmers because the level of dryness of Moringa leaves is not as desired by the market. The third problem is that it is not hygienic because Moringa leaves are dried in the open, and the drying containers are straightforward. Usually, Moringa farmers dry them using woven bamboo, zinc, and tarpaulin shelves, and some even put them directly on the ground.

Therefore, a moringa leaf dryer is made that can solve all the problems mentioned above. Moringa leaf dryer has a capacity of 20 kilos; heating at night takes three incandescent lamps with 120 watts of electric power and usage for 8 hours starting from 5 pm to 2 am. For cooling, it takes 6 fans of 20 watts each. The required temperature in the drying process ranges from 37 ºC to 40 ºC. So to maximise the energy consumption in the moringa leaf dryer, evaluation of power consumption on moringa leaf dryer is appropriate and efficient.

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2 LITERATURE STUDY

2.1 Energy Audit

An energy audit is the first step in recording energy consumption data, identifying sources of energy wastage, analysing the possibility of energy saving, and calculating the necessary steps. In addition, the energy audit aims to find out "Portrait of Energy Use" and look for efforts to improve energy efficiency.

2.2 Parameters for Calculating Power

The velocity at which electricity flows at one point on the power grid is called an electrical power. The unit of electricity in watts or joules per second in SI. Electric power becomes measurable when electricity producte by the plant and the absorb by the electricity load. Power is negative when electrical power flows from the circuit into the electrical capacity. Electric power is divided into power triangles: apparent power, active/real power and reactive power.

1. Real Power

Real power is the electrical power used by consumers for electrical machinery or other equipment after multiplied cos φ.

With the formula:

- Phase to neutral (1 phase) :

$$P = V \times I \times \cos\varphi \quad (1)$$

- Phase to phase (3 phase) :

$$P = V \times I \times \cos\varphi \times \sqrt{3} \quad (2)$$

Where:
P = real power (Watt or J/s)
V = voltage (Volt)
I = current flowing on the delivery (Ampere)
cos φ = power factor

2. Reactive Power

Reactive power arises due to inductive/capacitive reactive load and this power is used for mechanical and heat. Reactive power results from the magnitude of the voltage-current influenced by the power factor with the Unit Volt Ampere Reactive (VAR).

With the formula:

- Phase to neutral (1 phase):

$$Q = V \times I \times \sin\varphi \quad (3)$$

- Phase to phase (3 phases):

$$Q = V \times I \times \sin\varphi \times \sqrt{3} \quad (4)$$

Where:
Q = reactive power (VAR)
V = voltage (Volt)
I = current (Ampere)
φ = angle between current and voltage

3. Apparent Power

Apparent power is generated from a power source or power plant and is an electrical power that flows through the middle and currents flowing through the transmission—the only volt-ampere (VA).

With the formula:

- Phase to neutral (1 phase):

$$S = V \times I \quad (5)$$

- Phase to phase (3 phase):

$$S = \sqrt{3} \times V \times I \quad (6)$$

Where:
S = Apparent power (VA)
V = voltage (Volt)
I = current flowing on the transmission (Ampere)

The power triangle relationship is shown in figure 1.

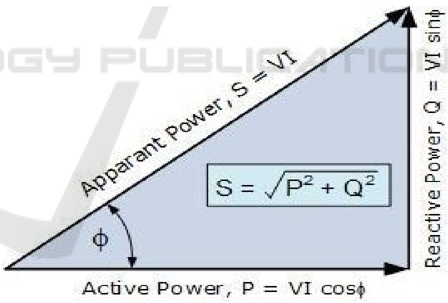

Figure 1: Power Triangle.

2.3 Drying

Drying is a hydrating process, which means removing water from a material. The drying or hydration process occurs when the dried material loses some or all of the water it contains. The primary technique that occurs after the drying process is evaporation. Evaporation occurs when the water collected by a material evaporates when heat is given to the material. This heat can be supplied through various sources, such as firewood, oil and gas, new charcoal or solar power. Drying can also take place in other ways, namely by breaking (Handini, 2008).

The drying process is influenced by temperature, ambient air humidity, drying air flow rate, desired moisture content, drying energy and drying capacity. Drying that is too fast can damage the material because the surface of the material dries too quickly so that it can't be balanced with the speed of movement of water from the material to the surface. Furthermore, fast-drying causes the hardening of the material's surface so that the water in the material can no longer evaporate due to obstruction. In addition, dry conditions with temperatures that are too high can damage the material. Setting the temperature and drying time is done by paying attention to the contact between the dryer and the heating device (in the form of hot air flowing or other heating devices). However, for the sake of considerations of nutritional standards, heating is recommended no more than 85^0C (Ismawati, Pengeringan, 2012).

2.4 Energy Conversion Mechanisms

When two or more objects are in thermal contact, heat will flow from an object with a higher temperature to an object with a lower temperature until thermal equilibrium is reached. This heat transfer process takes place in 3 mechanisms, namely:

1. Conduction
2. Convection
3. Radiation

The definition of the thermal efficiency of a solar collector is the comparison between the energy used and the amount of solar energy received at a specific time (A. Jansen. T.J, Teknologi Rekayasa Surya, 1995), the air is heated in the collector and rises due to natural convection. The heat is stored in the rock, and the air is then re-entered into the collector's base. The heat is removed from the relief drift by natural convection or rapid air circulation through the collector and storage. So the store must be located as far as possible above the collector.

2.5 Fishbone Diagram

To provide an overview of research activities, the stages of research work, outputs, and measurable achievement indicators, can be seen through the fishbone diagram and research chart in Figure 3 below:

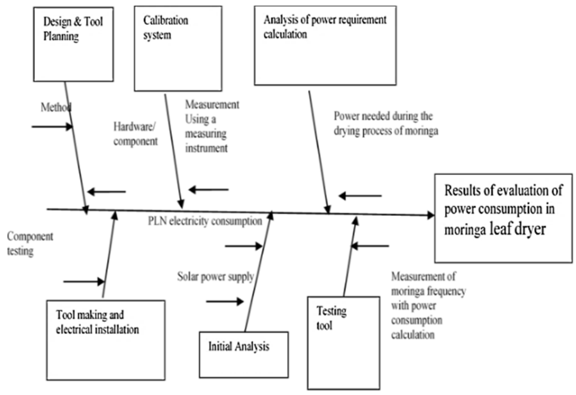

Figure 2: Fishbone Diagram.

3 METHOD

The following is the methodology used in the study to evaluate the power consumption of the moringa leaf dryer.

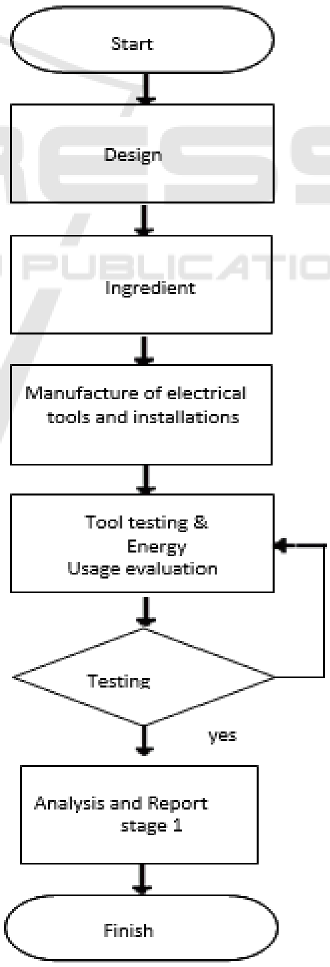

Figure 3: Research Flowchart.

There are three stages in this research: the design of the tool, the manufacture, installation of the device and the testing of the tool, and the evaluation of the power consumption of the tool. The variable parameters in this study are:

1. Moringa leaf drying process time
2. Calculation of power supply from collectors and PLN electricity

Sub Variable:

a) Drying evenly on moringa leaves
b) Collector's power supply
c) The average time used to dry the leaves perfectly
d) Evaluation of the power used in the entire drying process

3.1 Research Procedure

The research carried out is applied from the results of planning, which is suitable for research to observe the condition of the tool directly. The research procedure includes

1. Design & Planning
2. Material selection
3. Making tools and electrical installations
4. Installation
5. Tool testing and evaluation of power usage
6. Repair,
7. Data collection,
8. Analysis and report generation.

3.2 Types and Sources of Data

The data sources and types of data in this study consisted of primary data, namely data that were directly measured in the field and the results of the calculation of the information design obtained from the measurement results, and secondary data that supported primary data and the results of observations and document data.

3.3 Data Collection Techniques

Data collection techniques consist of primary and secondary data, namely: In preliminary data, the researcher uses data collection techniques and measurements directly in the field, the results are recorded according to the data group and observes and analyses the Moringa leaf dryer that has been made, and records the phenomena that occur—being researched. While secondary data, researchers collect data from literature both in books and secondary data works and perform data analysis.

3.4 Data Analysis

Data analysis, both primary data and secondary data were analysed in the following way:

1. Analysis of quantitative research

   Researchers measure the existence of a variable using research instruments. Then analyse looking for the relationship of one variable with other variables.

2. Description analysis

   Data is analysed according to the data group using experimental methods and actions. Both ways are determined by paying attention to the cause of the occurrence.

3. Trial/Testing Prosedure

   Before testing moringa leaves, ensure all ingredients are in good condition and have gone through the cleaning process. Ensure the shelves in the dryer oven are in good condition and all shelves are filled with Moringa leaves neatly and densely. Ensures the temperature on the collector up to 50 C and the maximum room temperature of 40 after the Moringa leaves dry.

4. Measuring Instrument

   Measuring instruments are required to obtain the data to be analysed. In this research, Scales and thermometer are utilized in collecting data.

Figure 4: Scales.

Scales used to measure the mass of the product before and already dried. A thermometer used to measure the temperature of the inside of the oven.

Figure 5: Thermometer inside the dryer.

Figure 6: Thermometer for outer measurement.

5. Testing Stages

- Preparation

Preparing the equipment needed for the drying process of moringa leaves includes the preparation of the oven, namely the dryer shelves adjusted to the weight of the moringa leaves to be dried. Check the oven power plug, prepare the measuring instrument to be used. Turn on the electric heater, observing the oven temperature reaches the desired temperature (47°C)

- Data Retrieval

Data retrieval is done at the time difference of 1 hour each, starting from the start of the drying process. The measured data is Collector Temperature (°C), Dryer Room Temperature (°C), Outer Temperature(°C), Outer Humidity (%), Dryer Room Humidity (%), Current (A), Voltage (V). Measurements are performed on two conditions using and using Fan Dryer, Fan Air Flow and heater.

- Settlement

The completion stage of the drying process is done to end the series of drying processes by turning off the electric heater on the off button, removing the power plug in the oven, then eliminating the shelves containing dried moringa leaves and collecting them. Then the rack is cleaned off the crumbs of moringa leaves, followed by cleaning the inside of the oven and tidying and packing the measuring instrument used in the testing process.

4 DISCUSSION

Before drying, moringa leaves are first cleaned, separated from the yellow leaves and dirt attached to the leaves, then washed and queued. Moringa leaves are placed neatly so as not to accumulate each other so that in the drying process can be evenly distributed on all surfaces of the leaves.

Figure 7: The process of cleaning and washing Moringa leaves before being put into the oven for the drying.

The drying process of moringa leaves is carried out approximately for 24 hours. Moringa leaves are evenly styled on each shelf consisting of 5 parts with a total of testing that is 10,000 grams, 6000 grams, 4000 grams and 2000 grams.

Figure 8: Fresh Moringa leaves that have been leaned are put into the oven for the drying process.

Figure 9: The drying process of Moringa leaves with the half-dry result.

Figure 10: Drying moringa leaves with the result of an even drought.

Figure 11: Drying moringa leaves one rack.

A. Moringa Testing Data

In table 1, measurement is done to 10,000 grams moringa leaves with a difference of drying time of 1 hour. The Dryer Fan is on while Fan Air Flow inputs and outputs is set to on and off state at certain intervals of time. The heating process is done from morning to night. In the afternoon the heater was left in a state of off, while at night and dawn, the heater is on. Some parameters considered in data collection are :collector Temperature (°C), Dryer Room Temperature (°C) Outside Temperature (°C) Outdoor Humidity (%), and Dryer Room Inertia (%).

Table 1: Measurement of 10,000 grams of moringa leaves.

No	Time	Dryer Fan	Fan Air Flow		Heater	Collector Temperature (°C)	Drying Room Temperature (°C)	Outdoor Temperature(°C)	Humidity (%)	Drying Room Humidity (%)	Current (A)	Voltage (V)	Power (W), Cos Phi 0.9	Energi (KWh) ,1 hour duration	Energy in Rupiahs (Rp)
			Input	Output											
1	15:00	On	On	On	Off	45	32	33	40	80	0.1	214	19.26	0.0193	27.82492
2	16:00	On	On	On	Off	42	35	32	40	75	0.37	214	71.26	0.0713	102.9522
3	17:00	On	Off	On	On	37	34	31	40	73	0.37	210	69.93	0.0699	101.0279
4	18:00	On	Off	On	On	30	32	30	45	70	0.8	208	149.76	0.1498	216.3583
5	19:00	On	Off	On	On	28	33	29	45	65	0.8	208	149.76	0.1498	216.3583
6	20:00	On	Off	On	On	29	34	28	50	65	0.8	209	150.48	0.1505	217.3985
7	21:00	On	Off	On	On	26.5	35	26	50	60	0.8	209	150.48	0.1505	217.3985
8	22:00	On	Off	On	On	26	35.2	25.8	52	60	0.8	204	146.88	0.1469	212.1975
9	23:00	On	Off	On	On	25	35	25.5	52	60	0.8	204	146.88	0.1469	212.1975
10	00:00	On	Off	On	On	25	35	25.2	52	59	0.8	204	146.88	0.1469	212.1975
11	01:00	On	Off	On	On	25	35	25	52	57	0.78	203	142.51	0.1425	205.8784
12	02:00	On	Off	On	On	25	35	25	52	55	0.78	203	142.51	0.1425	205.8784
13	03:00	On	Off	On	On	25	35	24	52	50	0.75	203	137.03	0.1370	197.96
14	04:00	On	Off	On	On	25	35	24	52	50	0.75	203	137.03	0.1370	197.96
15	05:00	On	Off	On	On	25	35	24	40	45	0.73	202	132.71	0.1327	191.7319
16	06:00	On	Off	On	On	26	35	25	35	42	0.73	202	132.71	0.1327	191.7319
17	07;00	On	Off	On	On	28	36	27	30	38	0.73	202	132.71	0.1327	191.7319
18	08:00	On	Off	On	On	35	36	29	30	35	0.37	205	68.27	0.0683	98.62245
19	09:00	On	Off	On	Off	43	36	32	25	33	0.1	205	18.45	0.0185	26.65472
20	10:00	On	Off	On	Off	45	38	35	20	30	0.1	205	18.45	0.0185	26.65472
21	11:00	On	Off	On	Off	49	39	35	25	30	0.1	205	18.45	0.0185	26.65472
22	12:00	On	Off	On	Off	52	39	35	25	30	0.1	205	18.45	0.0185	26.65472
												Total		2.3008	3324.025
												Energy Consumption/ hour		0.1046	151.092

A. Calculation Analysis

1. Power Calculation (W) Formula:

P = Vx I x cos φ
I = 0.1 A
V= 214 V
Cos φ =0.9
P = 214 x 0.1 x 0.9
P = 19.26 watts

2. Energy Calculation (kWh)

Formula: E ; t = 1 hour
E = Pxt/1000

E = (19.26 x 1)/1000
E = 0.019 kWh

3. Calculation of Energy in Rupiah (basic electricity tariff = Rp. 1444.70

$E_{Rp} = E_{kwh\ x}$ Tdl

E = 0.0193 x Tdl
E = 0.0193 x (1444.70)
E = Rp. 27,82

4. Average Energy Consumption Hourly (in Kwh and Rupiahs)

Eave = Total Energy/ Drying Duration
Eave = 2.3008/22
Eave = 0.1046 Kwh/Hour
Eave (Rp) = 0.1046 x Rp. 1444.70
Eave = Rp. 151.11/ Hour

For Table 2, the price of electricity per kWh for the period April-June 2021 for 1300 VA and 2200 VA loads is Rp.1444.70. During measurement, the conditions are divided into three conditions, namely condition 1, condition 2 and condition 3. The time for condition 1 is 15.00-16.00, time for condition 2 is 17.00-08.00, and time for condition 3 is 09.00-12.00.

Some calculation:

Condition 1. Fan air flow for both input and output is on, while the heater is in the Off state.

- Energy consumption for 2 hours
  = 0.0193 + 0.0713 = 0.905 Kwh
- Energy Consumption in Rp, for 2 hours
  = 0.905 x Rp. 1444.70 =Rp. 130.78
- Average energy in Kwh
  = 0.905/2 Kwh
  = 0.0452 Kwh

Table 2: Energy Consumption Per Condition (Watt).

Condition	Total Energy		Average Energy consumption/ condition/Hour	
	Watt	Rupiah	Watt	Rupiah
1	0,0905	130,7771	0,045261	65,38857
2	2,1365	3086,629	0,133532	192,9143
3	0,0738	106,6189	0,01845	26,65472

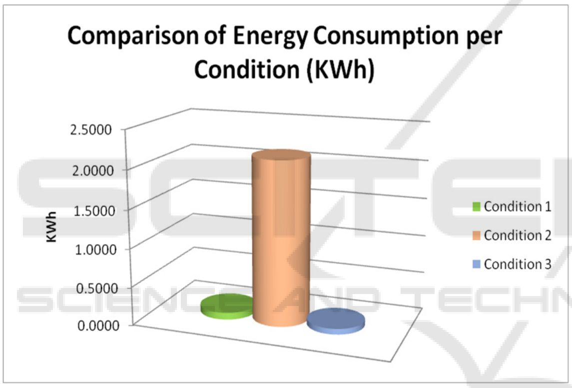

Figure 12: Energy graph per condition (watts).

The graph shows three conditions for energy consumptions and the highest average energy consumption is in condition 2, where the energy consumed is around 2,1365 Kwh or Rp.3086,629

Experiment with product capacity 6000 grams (Variation Oven Room Temperature)

Table 3: Moringa leaf measurement 6000 grams.

Time	Heater	Collector Temp. (°C)	Dryer Room Temp. (°C)	Outside temp (°C)	Outdoor Humidity (%)	Drying Room Humidity (%)
15.00	Off	45	32	33	40	85
18.00	On	30	32	30	45	80
23.00	On	25	35	25,5	52	65
09.00	Off	43	36	32	25	36
12.00	Off	52	39	35	25	36

Table 4: Moringa leaf measurement 4000 grams.

Time	Heater	Collector Temp (°C)	Dryer Room Temp (°C)	Outside temp (°C)	Outdoor Humidity (%)	Drying Room Humidity (%)
15.00	Off	45	32	33	40	90.2
18.00	On	30	32	30	45	88
23.00	On	25	35	25,5	52	70
09.00	Off	43	36	32	25	42
12.00	Off	52	39	35	25	42

Table 5: Moringa leaf measurement 2000 grams.

Time	Heater	Collector Temp (°C)	Dryer Room Temp (°C)	Outside temp (°C)	Outdoor Humidity (%)	Drying Room Humidity (%)
15.00	Off	45	32	33	40	97
18.00	On	30	32	30	45	90
23.00	On	25	35	25,5	52	79
09.00	Off	43	36	32	25	48,7
12.00	Off	52	39	35	25	50

5 CONCLUSIONS AND SUGGESTIONS

From the results of the dryness test of Moringa leaves starting at 15.00 until 12.00 the next day, the effects of Moringa drying are perfect, with even dryness on all Moringa leaf surfaces. Some parameters obtained from the measurement at 15.00 are Collector Temperature is at 45°C, Dryer Room Temperature is 32°C, Outside Temperature is 33°C, External Humidity is 40%, Drying Chamber Humidity is 80%, Current is 0.1 A and Voltage is 214 Volt.

For drying process of 10000 grams of Moringa, the Power (W) consumption with assumed power factor/ Cos Phi 0.9 is 19.26 Watts. The energy (KWh) for 1 hour is 0.0193 while the Energy in Rupiah (Rp) is Rp. 27.8249. As for the calculation of energy consumption per condition (wattage), in condition two, the average energy of 0.133532 watts is Rp. 192.9143

Suggestion:

Further development can increase the load capacity of Moringa; therefore, it can increase the amount of production. It is necessary to optimise the automatic control system for the drying temperature to be more optimal. And testing in full load needs to be done continuously to get more valid data.

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