

ANALYSIS OF THE DESIGN AND CONSTRUCTION OF A WATER SPINACH (IPOMOEA AQUATICA) VEGETABLE DRYING CHAMBER WITH A SPIRAL TYPE HEATER

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Abstrak.

Proses pengeringan pangan merupakan metode yang inovatif untuk mengubah proses pengurangan kadar air produk pangan segar asal tumbuhan yang bertujuan memperlambat kemunculan dan pertumbuhan mikroorganisme yang tidak diharapkan. Sistem pemanas ini mempunyai empat buah elemen pemanas (heater), dimana elemen pemanas yang digunakan mempunyai daya sebesar 1200W karena masing-masing elemen pemanas mempunyai daya sebesar 300W. Pada saat proses pengeringan diketahui rata-rata suhu udara pada ruang pengering lebih tinggi bila menggunakan energi matahari dibandingkan dengan sistem pemanas. Pengukuran suhu rata-rata pada siang hari adalah 38°C. Sedangkan pada malam hari, hasil pengukuran cenderung konstan, dengan rata-rata 34°C selama 7 jam dengan menggunakan sistem pemanas. Tegangan baterai menunjukkan peningkatan setiap jamnya. Pukul 08.30 tegangan aki 12,3V dan sampai pukul 16.00 tegangan 13,57V. Alat pengering ini bersumber dari energi matahari karena penggunaan energi matahari untuk pengeringan memerlukan waktu yang lebih lama yaitu 8 jam (08.30-16.00), dibandingkan dengan pengeringan menggunakan sistem pemanas selama 7 jam.

Kata kunci: kangkung, Ruang Pengeringan dan pemanas tipe spiral.

Abstract.

The food drying process is an innovative method to change the process of reducing the water content of fresh food products of plant origin to slow down the emergence and growth of unwanted microorganisms. This heating system has four heating elements, where the heating elements used have a power of 1200W because each heating element has a power of 300W. During the drying process, it is known that the average air temperature in the drying room is higher when using solar energy compared to a heating system. The average temperature measurement during the day is 38°C. The measurement results tend to be constant, with an average of 34°C for 7 hours using the heating system. The battery voltage shows an increase every hour. At 08:30 am the battery voltage was 12.3V, and until 16.00 the voltage was 13.57V. This dryer is sourced from solar energy because using solar for drying requires a longer time, namely 8 hours (08.30-16.00), compared to using a heating system for 7 hours.

Keywords: a water spinach, Drying Chamber and spiral type heater.

Introduction.

A dryer is a method used in food technology to extend the shelf life of a product by evaporating most of the water content of the material until it reaches a certain water content using heat energy to inhibit the rate of damage to the material due to biological and chemical activity [1][2]. Drying is one of the processes used to process food and industrial products. This drying is done to reduce the water content or moisture in the product. It is done to prevent microorganisms such as bacteria and fungi from making a product expire. Drying can also be done to facilitate the mass delivery of industrial and food products. It is beneficial because it can reduce the burden and size of piles of food, thereby saving shipping costs. Drying is divided into 2, namely natural drying and drying using artificial means. Each has its advantages and disadvantages. The advantage of natural drying is that it does not require special skills and equipment and is cheaper. The disadvantages of natural drying are that it requires a large area, depends on the weather, and is less hygienic. The advantage of artificial dryers is that the temperature and speed of the drying process can be controlled quickly and are not dependent on the weather. The disadvantage of artificial dryers is that they require special skills and equipment and incur high costs [3][4], [5].

The use of solar energy for drying can now be further optimized by making a greenhouse-effect dryer. However, currently, existing dryers are generally still constrained by drying, which can only be done during the day. The dryers are then equipped with other alternative energy such as biomass, electrical power, and coal. Drying with a dryer can also be done at night [6]. Drying agricultural products using solar energy is usually done by drying the products on a clothesline or lamporan, which is a large surface that can be made from various solid materials. According to the system and equipment, as well as economic factors, drying equipment can be made from woven mats, woven bamboo, zinc sheets, brick floors, or cement floors. This drying is the simplest. Drying is an effort to remove or reduce the water content of a material to obtain a water level that is safe enough to store, namely one whose water level is in balance with the environment [7]. Mechanical drying is a type of drying that uses fuel as a heat source (liquid, solid fuel, electricity). These mechanical drying tools include a tray dryer, rotary dryer, spray dryer, freeze dryer [8].

Convection drying is heat transfer by convection, which is divided into two parts, namely natural convection and forced convection. Natural convection occurs if the movement of a fluid is due to temperature differences in the fluid, such as a hot plate that is left in the surrounding air without any external source of movement. In forced convection, fluid movement occurs due to external coercion, tools that are often used, for example, blowers or pumps. In convection drying, almost all the heat needed to evaporate water and dry food comes from the heat itself, impinging on the air, and the dry air accumulates relatively on the surface of the food. The nature of air circulation determines the drying rate because the surface temperature of the product becomes slightly humid, and the water will constantly evaporate and cool the food. It is caused by the cooling effect during evaporation [9].

The heating element is a component that can convert electrical energy into heat energy. The heating element produces heat from the resistance process that occurs in high-resistance metals. Metal heating elements are divided into two types, namely, a mixture of Fe-Cr-Al and a mixture of Ni-Cr. The Ni-Cr mixture is also called Nichrome or nickel-chromium, with a composition of 80% nickel and 20% chromium. The metal is the most commonly found in heating elements because of its greater efficiency. There are various types of heating elements, one of which is the infrared heating element. Infrared heaters use ceramics as infrared wave reflectors, which produce wavelengths of 2-10 microns. Infrared heating elements are very efficient because they can produce heat of 300°C to 700°C using less electrical power than other heating elements [10].

The drying process is one of the agricultural product processing processes in industry. Whether it is used to preserve food or for industrial products, this is done to prevent microorganisms such as bacteria and fungi from making a product expire. Drying can also be done to make it easier to send bulk food to industrial and food products. So far, drying has been used using fire heat sources from combustion and the temperature of the sun. So, it takes a long time for the heat transfer process to occur, and it is disturbed by the frequently changing weather, so we cannot make maximum use of

the sun's heat. So, to overcome this problem, an oven was designed in the research. This research explores the working principle of the Heater, determines the capacity produced by the Spiral Heater in the kale drying house, and determines the design dimensions of the Heater in the kale drying house.

Research Methods

Creating a Tool Design Concept

Creating a Design Concept Tool is an important starting point that will indicate the direction of the design. This concept will underlie the logic, thinking, and reasoning for designing heating equipment in a spiral-type water spinach drying house.



Figure 1. A Water Spinach (*Ipomoea Aquatica*) Vegetable Drying Chamber With A Spiral Type Heater.

Assembly Process

Assembly is a process of arranging and combining several parts so that it becomes a tool or machine that has a specific function [11]–[17]. The assembly project begins when the object is ready to be installed and ends when the object is wholly formed. There are two assembly methods, namely, the balance method and the disassembly method. The balance method in assembly is the process of connecting components using spot welding. Spot welding is used in assembly to connect thin plates of material. What is meant by balance in this method is that the position of the joints at several points must be balanced to get maximum results. The knockdown method, also known as knockdown, is often used in production. The assembly process using the knockdown method usually uses a bolt and nut or screw connection. The advantages of the knockdown method include the following: it makes packaging, mobility, and transportation more accessible, makes maintenance and replacement of internal components easier, makes work operations easier, and simplifies product construction.

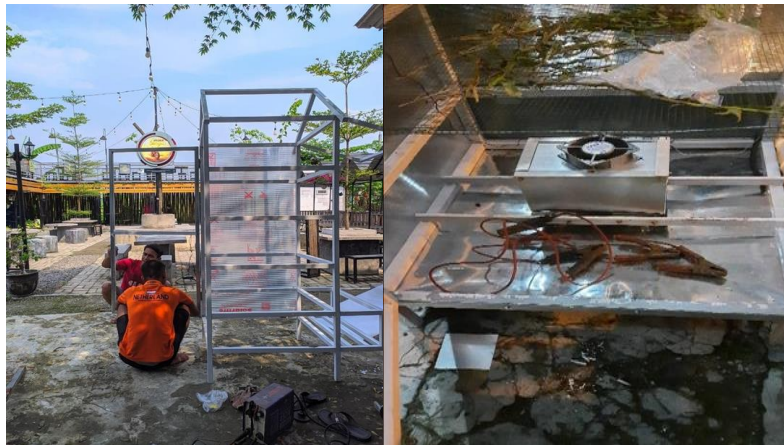


Figure 2. Assembly Process.

Machine Testing

Tool testing is the most critical stage in making a tool because with testing, we can find out the performance of the tool we make, whether it can operate according to its function and according to what is targeted, and from the results, we can find out the advantages and disadvantages of the tool [16], [18]. That we make. The tests carried out include collecting test results data by determining the capacity to be used and recording the time, temperature and pressure that occurs when testing the equipment.



Figure 3. Machine Testing Process.

Results and Discussion.

This machine test begins by measuring the heat temperature at the heater temperature using four heaters with a power capacity of 1200W, each element having a power of 300W, and the outdoor air temperature at 38°C. The aim of testing this tool is to find out whether the performance of the heater is in accordance with what was designed. Then, the data obtained is analyzed to determine the tool's level of success. Data collection is carried out with a time delay of one minute for each data collection. The following are the results of data collection when heating the heater, which are presented in Table 1.

Tabel 1. Test Results Are Based On Time And Product Temperature.

Testing Time (min)	Temperature In The Heating Chamber (°C)
10	28
20	31
30	42
40	62
50	70
60	82
70	105
80	240
90	295
100	325
110	380
120	425
130	425

Monitoring temperature is essential in a dryer because temperature is one of the parameters that influences the drying process. Therefore, a tool is needed to regulate the temperature so that it is stable by connecting and disconnecting the electricity using a sensor system, namely a Digital

Thermostat. The results of measurements from this temperature monitoring system during the drying process show that the average air temperature in the drying room is higher when using solar energy compared to a heating system. The average temperature measurement during the day is 38°C. Meanwhile, at night, the results of the measurements tend to remain constant, an average of 34°C for 6 hours using a heating system.

The battery voltage shows an increase every hour; at 08:30 in the morning, the battery voltage is 12.3V, and until 4:00 p.m., the voltage is 13.57V. This increase in voltage indicates that energy is being charged in the battery. Meanwhile, the amount of radiation will affect the current value of the heater. At night, the energy stored in the battery is then used to activate the heating system (heater) and blower. By activating the heating element, the energy stored in the battery is reduced. It is characterized by a decrease in voltage where the initial voltage is 12V to 11V in this condition. The heating system and blower will turn off automatically. This heating system only operates for 7 hours, which can be calculated by calculating the current use of 9.33A. It means that the energy in the battery cannot be used 100% because the battery lasts longer, so a value of 1.55 is obtained.

The water spinach drying house in this study lasted 15 hours a day with a combination of input energy that came from solar power and heat produced by the heating system (heater) and blower. This blower is part of the dryer, which functions to suck in hot steam and distribute it to the drying room. The most considerable energy input in this dryer comes from solar energy because the use of solar energy for drying takes longer, namely for 8 hours (08:30 am – 4:00 pm), compared to drying using a heating system for 7 hours, while the use of a blower is continuously operated during the drying process.

Conclusion.

The heating system has four heating elements (heaters), of which the heating element used has a power of 1200W because each heating element has a power of 300W. During the drying process, it is known that the average air temperature in the drying room is higher when using solar energy compared to the heating system. The average temperature measurement during the day is 38°C. Meanwhile, at night, the measurement results tend to remain constant, with an average of 34°C for 7 hours using a heating system. The battery voltage shows an increase every hour. At 08.30, the battery voltage is 12.3V, and until 16.00, the voltage is 13.57V. This dryer is sourced from solar energy because the use of solar energy for drying takes longer, namely 8 hours (08.30 am-4.00 pm), compared to drying using a heating system for 7 hours.

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