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Artificial Lightning in Solar Tunnel Dryer for Curry leaves

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ABSTRACT - Sun drying of agricultural products is the traditional method employed in most of the developing countries. Sun drying is used to denote the exposure of a commodity to direct solar radiation and the convective power of the natural wind. Solar drying can be considered as an advancement of natural sun drying and it is a more efficient technique of utilizing solar energy due to it's renewable, environmentally friendly technology. Nowadays drying agricultural products have great attention and there are various methods of drying fruits, vegetables such as dehydration, canning etc. due to this the quality of such product is degraded so solar dryer is used to avoid wastage, increase the productivity of agriculture, also the production in terms of quality and quantity. Solar tunnel dryer have some limitations like, it can be only used during day time when adequate amount of solar energy is present and a backup heating system is necessary for products require continuous drying, to overcome this limitations we can use artificial Lightning like high wattage Incandescent lamp for drying. This project describes suitability for small scale agricultural products drying process within a closed chamber, using Artificial Lightning. To start with, the electromagnetic radiations are used to internally heat the agricultural products to remove the water content. The graphs of time versus drying process obtained show that the artificial Lightning drying unit designed has worked as per the expectation by consuming less time compared to conventional drying process.

Keywords: Incandescent bulb, Sensor, Foldable Solar Dryer, LCD Display.

INTRODUCTION

Drying is an excellent way to preserve food and solar food drying is an appropriate food preservation technology for a sustainable world. The high moisture content in fresh agricultural product (produce) is the basic cause for spoilage. If water is removed, then the shelf life of produce increases. Traditional open sun drying methods often yield poor quality, since the produce is not protected against dust, rain and wind, or even against insects, birds, rodents and domestic animals while drying. The solution of all these problems is the use of solar dryer instead of open sun drying.

Solar dryers are the devices that use free solar energy to dry agro products. The studies indicate that cost of drying with solar energy is only one-third as compared to the cost using a dryer based on conventional fuels. Adequate drying helps to preserve the flavor, texture, and color of the food, which leads to a better quality product.

India is the second largest producer of vegetable in the world and contributes about 13% of world's vegetable production. The green leafy vegetables are rich sources of vitamins as well as minerals and fiber (Fathima *et al*., 2001). The leafy vegetables are highly perishable in nature and therefore have short life. The curry leaves provides health benefit by providing much needed dietary fibers, several essential minerals and vitamins to human diet. 100gm of curry leaves provides 108 kcal energy. The demand of fresh and dehydrated curry leaves has increased over last two decades. Mostly used methods for drying agricultural products like Curry leaves are microwave drying, oven drying, vacuum drying etc. due to this the quality of such product is degraded so solar dryer is used to avoid wastage, increase the productivity of agriculture, also the production in terms of quality and quantity.

METHODOLOGY

The design used for agro products drying chamber needs the temperature to be controlled throughout the drying process by using solar energy. Variable temperature conditions during drying are harmful for agro

products. Over drying causes discoloration and reduction in quality. On the other hand, under drying causes fungal infection and bacterial action. Thus main objectives are to design the solar tunnel dryer and to design a controlling circuit to control various drying parameters inside it.

1) Solar Tunnel Dryer:

The material used for construction of folding type small size passive solar tunnel dryer is given in the following table 1:

Table 1: Material required for solar tunnel dryer

Sr. No.	Item	Specification/ Quantity
1.	GI bar	8.92 m
2.	GI Sheet	26 gauge
3.	PVC pipe	5.49 m
4.	UV stabilized polythene sheet, thickness 200 microns	5 × 5 m^2
5.	Insulation(Plywood)	2
6.	Binder clips	28

The schematic design of solar tunnel dryer is shown in fig 1:

All dimensions in mm

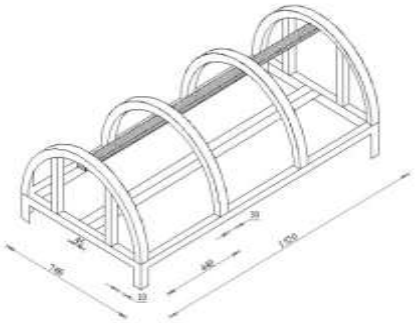

Fig. 1: Schematic Diagram of Solar Tunnel Dryer

2) Solar Tunnel Dryer with controlling circuit:

The above Solar Tunnel Dryers parameters are tested and controlled using Arduino as shown below

BLOCK DIAGRAM

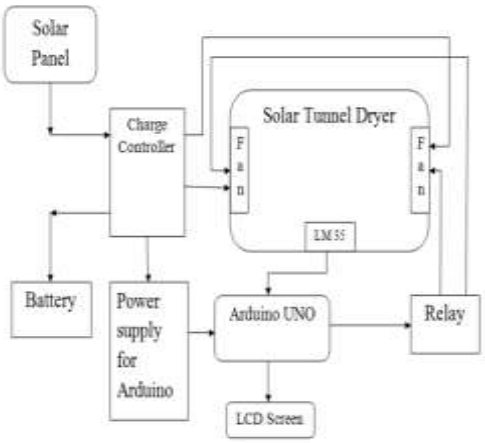

Fig. 2: Block diagram of solar tunnel dryer

CIRCUITRY

1. Arduino Uno

Table 2: Specifications of Arduino Uno

Operating Voltage	5V
Input Voltage	7-12V
Digital I/O	Pins 14
Analog Input	6 Pins
Length	68.6 mm
Width	53.4 mm
Weight	5

2. Temperature Sensor LM 35

Table 3: Specifications of Temperature Sensor LM 35

Supply Voltage	+35 V to -0.2 V
Output Voltage	+6 V to -1 V
Temperature Range	-55 °C to 150 °C

3. Relay

Table 4: Specifications of Relay

Operating Voltage	5 V DC
Nominal current	70 mA
Quantity	2

4. Liquid Crystal Display

Table 5: Specifications of Liquid Crystal Display

Operating Voltage	5 V DC
Module Dimension	60 mm x 36 mm x 15 mm
Viewing Area Size	64.5 mm x 16 mm
Displays	2 lines x 16 characters

5. Exhaust Fan

Table 6: Specifications of Exhaust Fan

Operating Voltage	5 V
Dimension	100mm × 100 mm × 10 mm

6. Solar Panel

Table 7: Specifications of Solar Panel

Rated Power	10 Watt
Open circuit voltage (Voc)	21.5 Volt
Short circuit current (Isc)	0.65 Ampere
Voltage at maximum power (Vmp)	17.7 Volt
Current at maximum power (Imp)	0.57 Ampere
Maximum system voltage	600lt

7. Battery

Table 8: Specifications of Battery

Voltage	12 Volt
Capacity	7 Ah
Type	Sealed Lead Acid Battery
Rechargeable	Yes

8. Charge controller

Table 9: Specifications of Charge Controller

Voltage	12 Volt
Max. PV charging Current	5 Ampere
Max. load	5 Ampere

Fig. 3: Actual View of circuit diagram

The measurements of the parameters were taken after every half hour.

Table: 10 Parameters measured and instruments used

Parameter	Instrument
Temperature	Digital Thermometer
Relative Humidity	Hygrometer
Air Velocity	Digital Anemometer
Solar Radiations	Pyranometer

Flow chart of Sapota drying is given below:

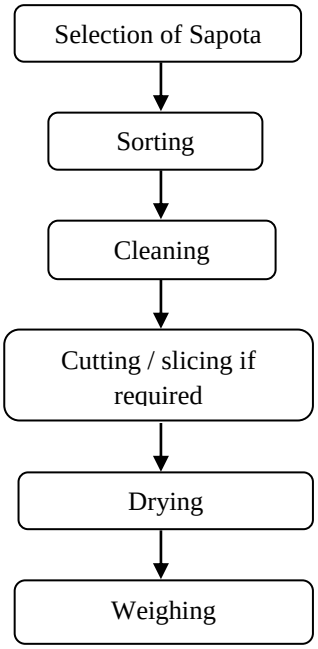

Fig. 4: Flow chart of drying Sapota

Determination of Moisture Content:

$$\text{Moisture content \% (wb)} = \frac{W_2 - W_3}{W_2 - W_1} X\ 100$$

Where,

W_1= Weight of empty box, g.

W_2=Weight of sample before drying, g.

W_3=weight of sample after drying, g.

RESULT AND DISCUSSION

Evaluation of Solar Tunnel Dryer for No load condition

Evaluation and testing of the Solar Tunnel Dryer was carried out under no load conditions.

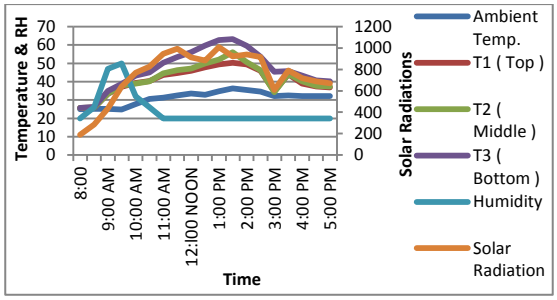

Fig. 5: Variation of Temperature, Humidity and Solar Radiation with Time at No load condition

It was observed that the minimum inside temperature was 25.7^{0}C at 8:00 am and also observed that the minimum and maximum dryer humidity was 20 % and 50% from 08:00 am to 5:00 pm respectively. The minimum and maximum base temperature is 25.7^{0}C at 08:00 am and 63.2^{0}C at 1:30 pm respectively. The minimum solar radiation was observed at 08:00 am and maximum at 1:00 pm were 189 and 1008 W/m^2 respectively.

Fig. 5 shows that minimum and maximum temperature of dryer, ambient temp, humidity, solar radiation. It was observed that the minimum and maximum ambient temperature of air was observed at 8:00 am and 01:30 pm that is 25.0^{0}C and 36.2^{0}C respectively.

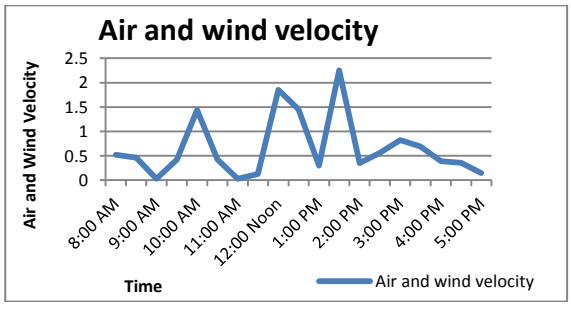

Fig. 6 Variation of Air Flow Velocity with Time at No load condition

Fig. 6 shows that the variation of air flow velocity of wind velocity with respect to time. The minimum & maximum air flow velocity was observed at 09:00 am and 01:30 pm, 0.03 m/s and 2.25 m/s respectively.

Evaluation of Solar Tunnel Dryer for Curry Leaves in Artificial Lightening

Evaluation and testing of the Solar Tunnel Dryer was carried out under load conditions during the month of February 2019 for drying of Curry Leaves r in artificial light.

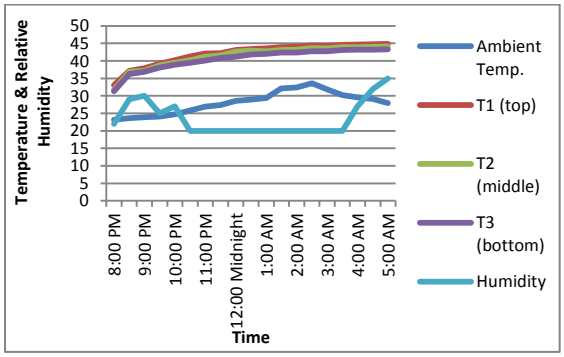

Fig. 7: Variation of Temperature, Humidity and Solar Radiation with Time

On the day of drying it was observed that the minimum inside temperature was 31.8^{0}C at 8:00 pm and also observed that the minimum and maximum dryer humidity was 20 % and 35 % from 08:00 pm to 5:00 am respectively. The minimum and maximum base temperature is 31.3^{0}C at 08:00 pm and 43.3^{0}C at 05:00 am respectively.

Fig. 7 shows that minimum and maximum temperature of dryer, ambient temp, humidity. It was observed that the minimum and maximum ambient temperature of air was observed at 8:00 pm and 02:30 am that is 23.2^{0}C and 33.6^{0}C respectively.

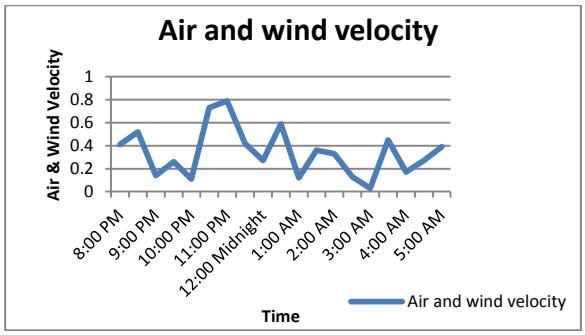

Fig. 8 Variation of Air Flow Velocity with Time

Fig. 8 shows that the variation of air flow velocity of wind velocity with respect to time. The minimum & maximum air flow velocity was observed at 03:00 am and 11:00 pm, 0.03m/s and 0.79 m/s respectively.

Fig. 9: Curry leaves before drying

Fig. 10: Curry leaves after drying

Determination of Moisture Content

Table 11: Initial Moisture Content of Curry Leaves

Weight of empty box gm	Weight of empty box + Weight of sample before oven drying (W_2) gm	Weight of empty box + Weight of sample after oven drying (W_3) gm	Moisture content % (wet basis)
59.3	68	62.25	66

Table 12: Moisture Content of Curry Leaves after Drying

Weight of empty box gm	Weight of empty box + Weight of sample before oven drying (W_2) gm	Weight of empty box + Weight of sample after oven drying (W_3) gm	Moisture content % (wet basis)
59.3	65	64.77	4

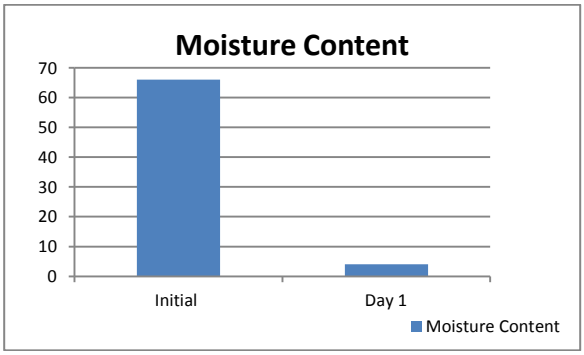

Fig. 11: Removal of moisture from curry leaves

From the fig. 11 it is observed that curry leaves require 1 day for drying. The drying rate is high. It is found that the initial moisture content of curry leaves was 66% which was reduced to 4 % in 1 day

CONCLUSIONS

Using the concept of basic solar conduction dryer and implementing the automation and design enhancement, quality of agro products has been increased. By utilizing large amount of solar heat to maintain the quality of the food products is also achieved. From the experiment performed, the dryer accomplishes the temperature control at desired temperature.

The overall reading observed that the maximum inside temperature was 45^0C. Corresponding average ambient temperature was 32.52^0C. It was also observed that the average solar radiation was 800 W/m^2, average humidity was 20 % and average the air flow velocity was 0.89 m/s. The initial moisture content of Coriander was 66% which was reduced to 4 % in one day.

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