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Artificial Lightning in Solar Tunnel Dryer for Coriander

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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 its 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, but in rainy or cloudy season due to non availability of enough solar radiations, proper drying is not achieved. India is the largest producer of coriander i. e. 9.23 lac tones per annum during the year 2017-2018. Coriander is widely cultivated in Rajasthan, Gujarat, Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu. It is perishable vegetable with moisture content of 80-90% which can be reduced down to 5-10% by drying in order to increase the shelf life. Mostly used methods for drying agricultural products like Coriander 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

BLOCK DIAGRAM

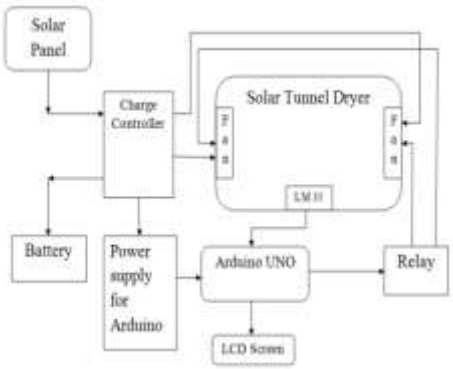

Fig. 2: Block diagram of solar tunnel dryer

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	25 g

2. Temperature Sensor LM35

Table 3: Specifications of temperature sensor LM35

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	600 lt

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 coriander drying is given below:

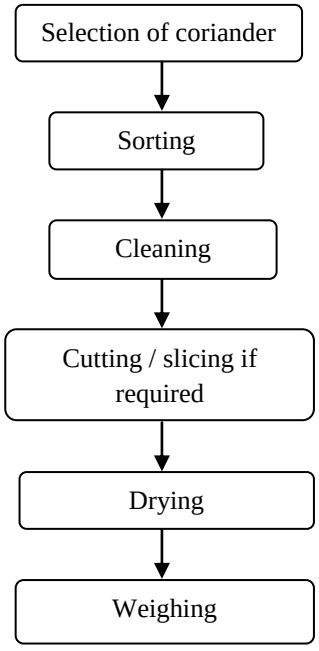

Fig. 4: Process of drying coriander

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.

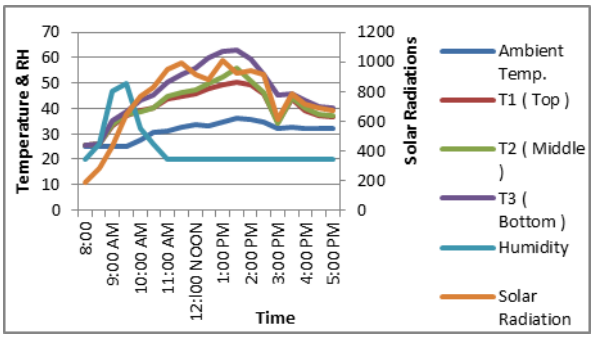

Fig. 5: Variation of temperature, humidity and solar radiation with time at no load condition

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 32% 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.

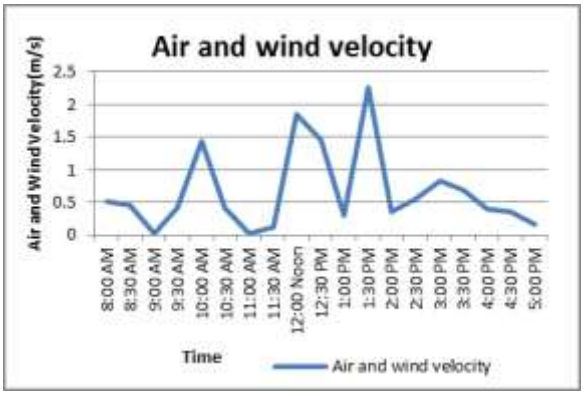

Fig. 6: Variation of air flow velocity with time at no load condition

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 Coriander

Evaluation and testing of the Solar Tunnel Dryer was carried out under load conditions for drying of coriander.

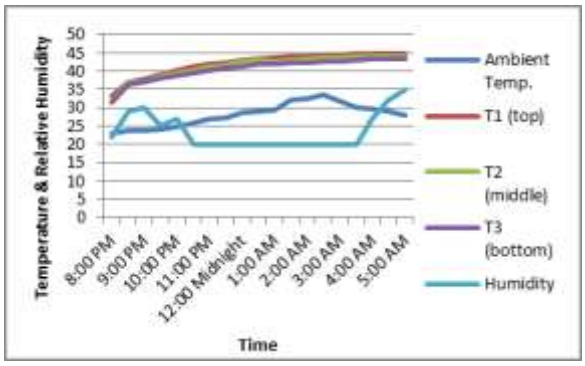

Fig. 7: Variation of temperature, humidity and solar radiation with time

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.

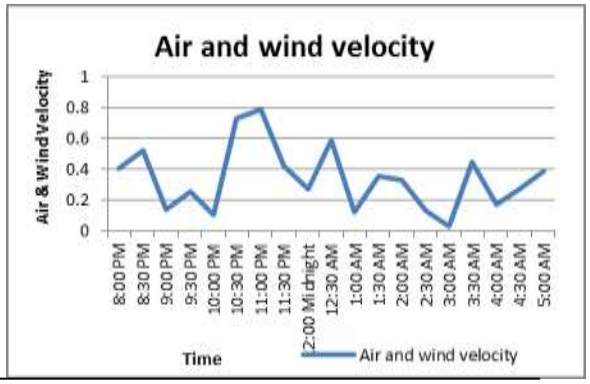

Fig. 8 Variation of Air Flow Velocity with Time

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: Coriander before drying

Fig. 10: Coriander after drying

Determination of Moisture Content:

Table 11: Initial moisture content

Weight of empty box (W_1) g	Weight of empty box + Weight of sample before oven drying (W_2) g	Weight of empty box + Weight of sample after oven drying (W_3) g	Moisture content % (wet basis)
59.3	66	60.01	89.5

Table 12: Moisture Content of Coriander after Drying

Weight of empty box (W_1) g	Weight of empty box + Weight of sample before oven drying (W_2) g	Weight of empty box + Weight of sample after oven drying (W_3) g	Moisture content % (wet basis)
59.3	67	66.46	7

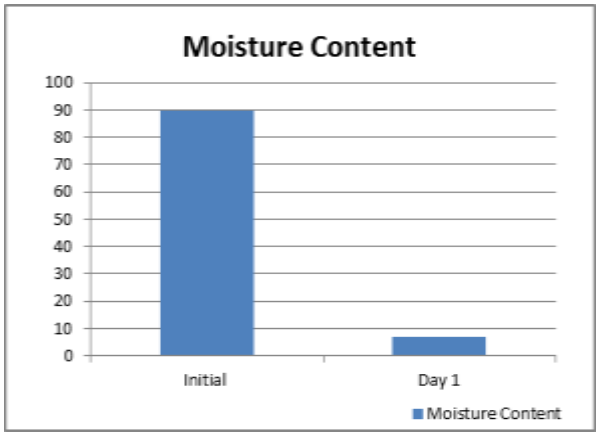

Fig. 11: Removal of moisture from coriander per day

From the fig. 9 it is observed that coriander require 1 day for drying. The drying rate is high. It is found that the initial moisture content of coriander was 89.5% which was reduced to 7% 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 89.5% which was reduced to 7 % in one day.

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