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Artificial Lightning in Solar Tunnel Dryer for Potato

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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. 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.

Potato is one among the foremost common food materials, consumed as main course with meat and vegetable in the form of mashed potato widely in many countries. Production of potato in India is about 46.61 million MT in year 2016. Potato consists of 63-83% moisture content. Raw potatoes can last for one to two weeks at traditional temperature.

To maximize the shelf life, potatoes were dried up to moisture level of approximately 10-12% under tropical ambient temperature. The solar dryer is used to avoid wastage, increase the productivity of agriculture, also the production in terms of quality and quantity. Mostly used methods for drying agricultural products like Potato are osmotic dehydration, microwave drying, oven drying, vacuum drying etc., due to this the quality of such product is degraded so artificial lightning dryer is used to avoid wastage, increase the productivity of agriculture, also the production in terms of quality and quantity [6].

METHODOLOGY

The design used for agro products drying chamber needs the temperature in drying process by using artificial lightning. 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 for continuous drying process design a artificial lightning drying unit.

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

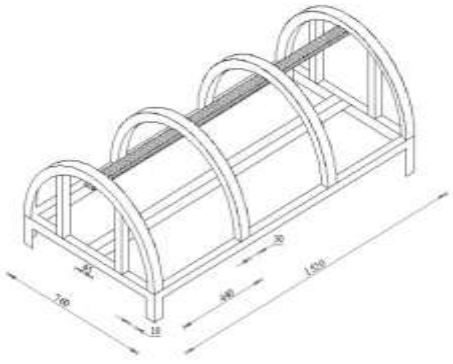

Fig. 1: Schematic Diagram of solar tunnel dryer

2) Solar Tunnel Dryer with artificial lightning unit:

The above Solar Tunnel Dryers parameters are tested by using Artificial lightning as shown below

BLOCK DIAGRAM

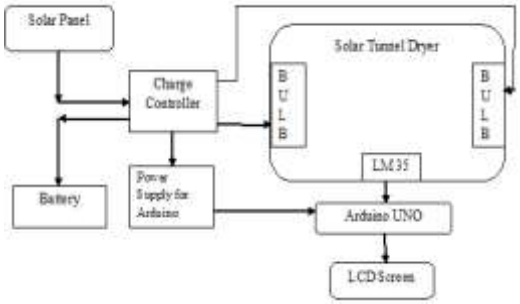

Fig. 2: Block diagram of artificial lightning solar tunnel dryer

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. Liquid Crystal Display

Table 4: 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

4. Solar Panel

Table 5: 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 Volt

5. Battery

Table 6: Specifications of battery

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

6. Charge Controller

Table 7: Specifications of charge controller

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

7. Incandescent Bulb

Table 8: Specifications of incandescent bulb

Lightning type	Incandescent
Wattage	200 W
Color Temperature	2700-3000 K
Body Material	Aluminum

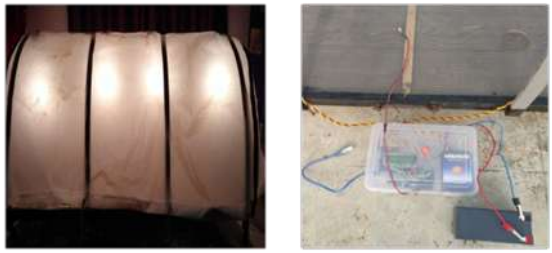

Fig. 3: Actual view of circuit diagram

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

Table 9: Parameters measured and instruments used

Parameter	Instrument
Temperature	Digital Thermometer
Relative Humidity	Hygrometer
Air Velocity	Digital Anemometer

Flow chart of potato drying is given below:

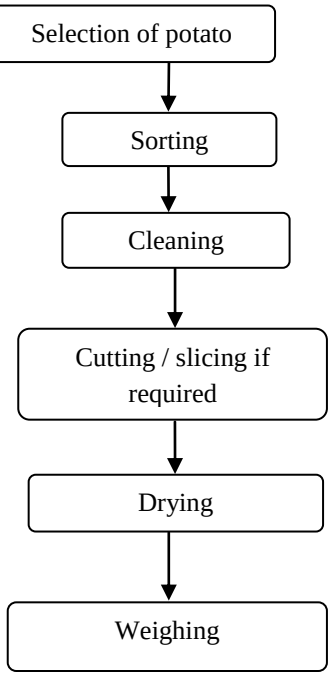

Fig. 4: Processing of drying potato

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.

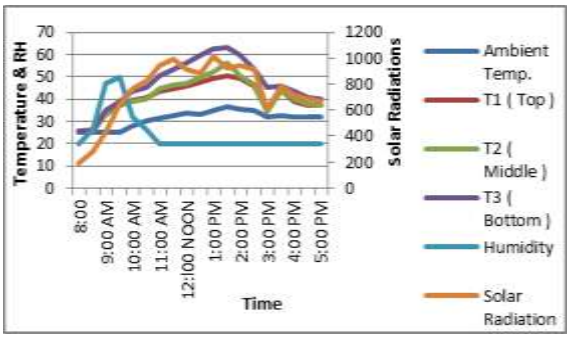

Fig. 5: Variation of temperature, humidity and solar radiation with time at no load condition

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.

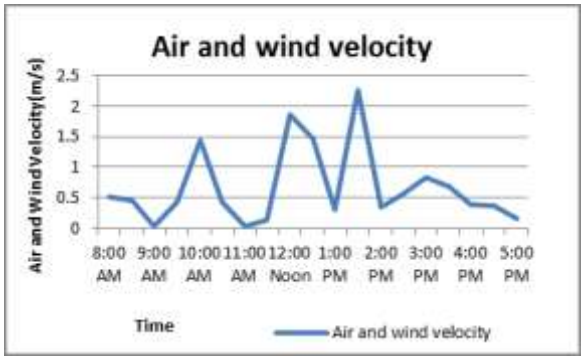

Fig. 6: Variation of Air Flow Velocity with Time at No load condition

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 Potato 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 Potato slices in artificial light.

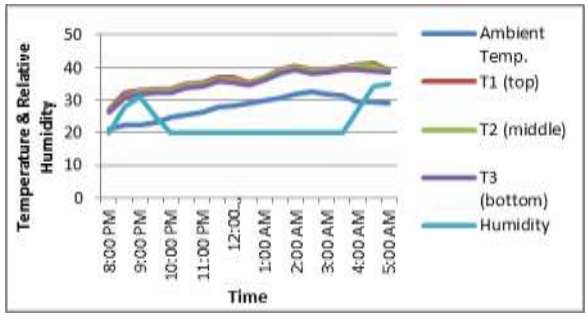

Fig. 7: Variation of temperature, humidity and solar radiation with time

On the first day of drying it was observed that the minimum inside temperature was 26.7^{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 26.1^{0}C at 08:00 pm and 39.3^{0}C at 02:00 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 21.2^{0}C and 32.4^{0}C respectively.

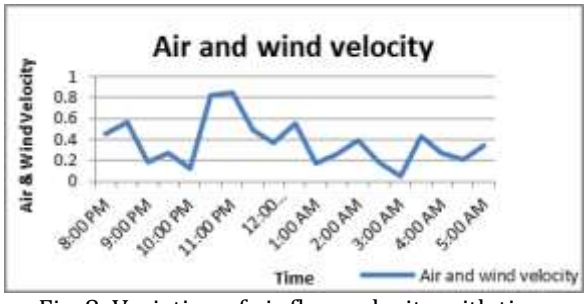

Fig. 8: Variation of air flow velocity with time

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, 0.05m/s and 0.85 m/s respectively.


Fig. 9: Potato before drying


Fig. 10: Potato after drying

Determination of Moisture Content for Artificial Lightning

Table 10: Initial moisture content of potato slices

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	60.61	83

Table 11: Moisture content of potato slices 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	65	64.72	5

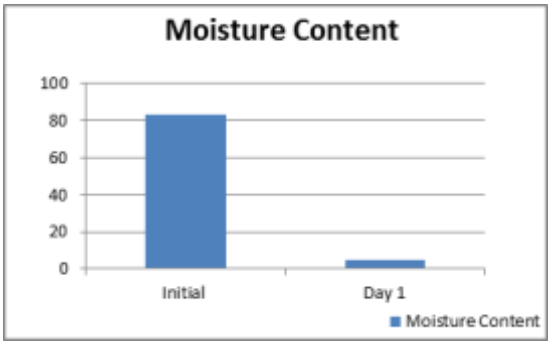

Fig. 11: Removal of moisture from potato per day

From Fig. 11 it is observed that potato only one day for drying. The drying rate is high. It is found that the initial moisture content of potato was 83% which was reduced to 5%.

The efficiency of small size folding type passive solar tunnel dryer for potato slices was observed to be 33.86%

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 31.4^0C. It was also observed that the average electromagnetic radiations 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 Sapota slices was 83 % which was reduced to 5 % in 1 day.

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