iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** IX **Month of publication:** September 2020

DOI: https://doi.org/10.22214/ijraset.2020.31615

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

Comparison of Performance for Drying Leafy Vegetables for that Plate Type Tunnel Dryer and Evacuated Tubes Type Tunnel Dryer

Prof. S. R. Patil[1], Mr. R. S. Yadav[2]
[1]*Department of Heat power Engineering, PVPIT, Budhgaon*

Abstract: India is the third larger producer of fruits and vegetables in the world. These products are planning mainly for domestic consumption and sale in the local area market. However, in case of surplus production, enormous losses occur because farmers neither have access to markets in big cities nor to the international market due to poor product quality and market reach. As another to the marketing of fresh fruits and vegetables, small farmers can think of conservation by drying. Drying is an essential process in the conservation of agricultural crops, wastewater treatment, and biomass treatment.

I. INTRODUCTION

The energy requirement for drying can be supplied from various sources, namely, fossil fuel, natural gas, electricity, wood, bark forest remaining, and solar. Although the use of solar radiation for drying has existed since a long ago times, it has not yet been widely commercialized, particularly in the agricultural sector. Considering the fast depletion of natural fuel resources and because of the rising fossil fuel cost, solar drying is expected to become indispensable in the future. Moreover, the main purpose of drying agricultural product is conservation, minimize storage and packaging spaces and make smaller weight for transportation and handling.

Solar drying is actually since the ancient time for preservation of food and agriculture crops. This was done particularly by open sun drying underneath open the sky. This process has several disadvantages like spoilage of product due to adverse climatic condition like rain, moist, wind and dust, loss of material due to birds and animals, failure of the material by decomposition, insects and fungus growth. Also the process is highly labor intensive, time consuming and requires large area. Thus solar drying is the best replacement as a solution of all the drawbacks of natural drying and unnatural mechanical drying. Solar dryers used in agriculture for food and crop drying.

II. DEVELOPMENT OF EXPERIMENTAL SETUP

A. Aspect to be Considered while Selecting the Dryer

For research work it is necessary to develop experimental test setup (system). The following points were considered in the design of the solar dryer system

1) The amount of moisture to be removed from a given quantity of wet leafy vegetables
2) Daily solar radiation to determine energy received by the dryer per day
3) The daily sunshine hours for the selection of the total drying time

a) *Heating Chamber:* The heating chamber should have the following characteristics in order to increase the efficiency

- Should have an appropriate size for its projected use.
- Should be a convenient height.
- The floor and walls inside the drying chamber should be of a dark colour.

b) *Determining Optimum collector Slope:* From the general knowledge of the apparent movement of the sun it can be seen that during the drying season the sun will be overhead at or near the tropic of Capricorn. Thus for a dryer situated in the northern hemisphere a south facing collector will receive most insolation. To calculate the optimum slope angle, taking March 15 as the midpoint of the drying season. Angle of declination δ is the angle made by the line joining centers of sun and the earth with the projection of this line on the equatorial plane. It arises by the virtue of the fact that the earth rotates about an axis which makes an angle of approximately 66.5^0 with the plane of its rotation around the sun. The declination angle varies from a maximum value of $+23.45^0$ on June 21 to a minimum value of -23.45^0 on December 21. δ is given by following relation

$$\delta \text{ (in degrees)} = 23.45 \sin\left[\frac{360}{365}(284+n)\right] \quad (2.1)$$

Where n is the day of the year

For March 15, $n = 74$

Hence

$$\delta \text{ (in degrees)} = 23.45 \sin\left[\frac{360}{365}(284+74)\right]$$

$$= 23.45 \sin[\,0.9863\,(284+74)]$$

$$\delta = -2.82^0$$

But the angle of inclination (β) of collector for specific plane is generally taken as latitude plus 10 to 15 degrees.

Therefore for Islampur,

Angle of latitude = 16.870

And angle of inclination (β) = 16.870+10

$$\beta = 26.870^0$$

To maximize the level of insolation on a collector the simplest approach is to situate the collector so that it is perpendicular to insolation at mid-day in the middle of the dry season.

B. Performance Analysis of solar Tunnel Dryer

The performance of the dryer is evaluated by measuring the parameters like variation in moisture content, temperatures at various locations inside the drying chamber, Outdoor temperature variation, relative humidity, drying rate, drying time.

1) Moisture Determination

a) Dry basis:

The moisture content on dry basis (Md_o) of the leafy vegetable is expressed as

$$Md_o = \frac{W_o - W_d}{W_d} \times 100\% \quad (2.2)$$

The instantaneous moisture content of leafy vegetables on dry basis (Md_i) at any time (t_i) during the drying process is determined by following equation

$$Md_i = \frac{W_i - W_d}{W_d} \times 100\% \quad (2.3)$$

Where W_i is the weight of leafy vegetable at time t_i in kg.

b) Wet basis:

The moisture content on wet basis (Mw_o) of the leafy vegetable is expressed as

$$Mw_o = \frac{W_o - W_d}{W_o} \times 100\% \quad (2.4)$$

The instantaneous moisture content of leafy vegetables on wet basis (Mw_i) at any time (t_i) during the drying process is determined by following equation

$$Mw_i = \frac{W_i - W_d}{W_o} \times 100\% \quad (2.5)$$

Where W_i is the weight of leafy vegetable at time t_i in kg.

2) Drying Rate

The instantaneous drying rate DR_i is determined by using following equation

$$DR_i = \frac{\Delta W_i}{T_d} \quad (2.6)$$

Where,

ΔW_i is the difference of weight between when two successive measurements of a drying material (leafy vegetables) is made.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

3) System Drying Efficiency (η_d)

The system drying efficiency is defined as the ratio of the energy required to evaporate the moisture to the energy supplied to the dryer. For solar calculations the heat supplied to the dryer is the insolation upon the collector.

The system drying efficiency is calculated from the equation

$$\eta_d = \frac{\text{Amount of water removed from vegetable} \times H_L}{A_c \times I_i} \times 100\%$$

$$\eta_d = \frac{m_W - H_L}{A_c \times I_i} \times 100\% \qquad (2.7)$$

Where,

m_w = Amount of moisture evaporated or removed (kg)

$m_w = W_{i-1} - W_i$ where W_{i-1} and W_i are successive weight corresponding to when two successive measurements of a drying material is made.

H_L = Latent heat of vaporization of water, 2320 (kJ/kg)

A_c = Area of the collector (m^2)

I_i = Instantaneous solar insolation upon collector

III.EXPERIMENTAL INVESTIGATION

Table 1 : Prototype dimensions used for testing solar tunnel dryer

Sr. No.	Component	Particular	Value (mm)
1	Flat plate collector	Length	1250
		Width	500
		Thickness	3
2	Evacuated type collector	Length	1250
		Tube diameter	
		Tube Thickness	3
3	Dryer	Length	1000
		Width	1000
		Height	580
4	Dryer tray	Length	700
		Width	520
		Height	50
5	Glass cover thickness	-	6

Table : Prototype dimensions used for testing solar tunnel dryer

IV.CONCLUSIONS

The purpose of drying agricultural products using solar tunnel dryer is to improve the quality of drying and preserve the products. The solar tunnel dryer has been designed and fabricated for drying leafy vegetables. The effects of different atmospheric conditions on the drying leafy vegetables are carefully observed. For the comparison performance of dryer following points are considered.Causal Productions permits the distribution and revision of these templates on the condition that Causal Productions is credited in the revised template as follows: "original version of this template was provided by courtesy of Causal Productions.

Table2: Result comparison of Evacuated tube type tunnel dryer for drying curry leaves

Sr. No.	Particular	Air velocity		
		0.5 m/s	0.6 m/s	0.7 m/s
1	Final moisture content on W.B. (%)	Fogging was Occurred because the air velocity was not sufficient to Throughout the moist air	2.47%	3.04%
2	Total Drying time required		3 hours 45 minute	4 hour
3	Maximum drying rate		0.004 (kg/min)	0.003 (kg/min)
4	Average drying rate		0.00197(kg/min)	0.0016(kg/min)
5	Average System drying efficiency		14.932%	13.48%

Table 2: Result comparison flat plate type solar tunnel dryer for drying curry leaves

Sr. No.	Particular	Air velocity		
		0.5 m/s	0.6 m/s	0.7 m/s
1	Final moisture content on W.B. (%)	Fogging was Occurred because the air velocity was not sufficient to Throughout the moist air	3.61%	3.75%
2	Total Drying time required		3 hours 45 minutes	4 hours 15 minutes
3	Maximum drying rate		0.004(kg/min)	0.0032(kg/min)
4	Average drying rate		0.0018(kg/min)	0.0015(kg/min)
5	Average System drying efficiency		15.02%	11.75%

Table3: Result comparison of Evacuated tube type tunnel dryer for drying fenugreek

Sr. No.	Particular	Air velocity		
		0.5 m/s	0.6 m/s	0.7 m/s
1	Final moisture content on W.B. (%)	Fogging was Occurred because the air velocity was not sufficient to Throughout the moist air	7.92%	8.12%
2	Total Drying time required		5 hours 30 minutes	6 hours 30 minutes
3	Maximum drying rate		0.0043(kg/min)	0.0040(kg/min)
4	Average drying rate		0.00237(kg/min)	0.00196(kg/min)
5	Average System drying efficiency		17.08%	14.96%

Table4: Result comparison flat plate type solar tunnel dryer for drying fenugreek

Sr. No.	Particular	Air velocity		
		0.5 m/s	0.6 m/s	0.7 m/s
1	Final moisture content on W.B. (%)	Fogging was Occurred because the air velocity was not sufficient to Throughout the moist air	8.22%	8.62%
2	Total Drying time required		5 hours 30 minutes	6 hours 30 minutes
3	Maximum drying rate		0.0041(kg/min)	0.0040(kg/min)
4	Average drying rate		0.0024(kg/min)	0.00199(kg/min)
5	Average System drying efficiency		17.035%	14.84%

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

Table 5: Result comparison of Evacuated tube type tunnel dryer for drying coriander

Sr. No.	Particular	Air velocity		
		0.5 m/s	0.6 m/s	0.7 m/s
1	Final moisture content on W.B. (%)	Fogging was Occurred because the air velocity was not sufficient to Throughout the moist air	6.51%	6.21%
2	Total Drying time required		5 hours 30 minutes	5 hours 45 minutes
3	Maximum drying rate		0.0048(kg/min)	0.0038(kg/min)
4	Average drying rate		0.0027(kg/min)	0.0021(kg/min)
5	Average System drying efficiency		17.03%	20.01%

Table 6: Result comparison flat plate type solar tunnel dryer for drying coriander

Sr. No.	Particular	Air velocity		
		0.5 m/s	0.6 m/s	0.7 m/s
1	Final moisture content on W.B. (%)	Fogging was Occurred because the air velocity was not sufficient to Throughout the moist air	6.71%	6.71%
2	Total Drying time required		5 hours 30 minutes	5 hours 45 minutes
3	Maximum drying rate		0.0040(kg/min)	0.0038(kg/min)
4	Average drying rate		0.0023(kg/min)	0.0022(kg/min)
5	Average System drying efficiency		16.89%	19.70%

REFERENCES

[1] Rajendra Patil, et al. "A review on solar tunnel greenhouse drying system", Science Direct November 2015.
[2] S.V. Navale, et al. "Dehydration of leafy vegetables using cabinet solar dryer".Indian Streams Research Journal March 2013
[3] A. D. Choudhari, et al. "A rewiew of solar dryers technologies", international journal of research in advent technology,vol.2, Feb 2014.
[4] A.A. El-Sebaii, et al. "Experimental investigation of an indirect-mode forced convection solar dryer for drying thymus and mint", science Direct june2013.
[5] Ranko Goic, et al. "A review of solar drying technologies", Science Direct March2012.
[6] G. Pirasteh, et al. " A review on development of solar drying applications", Science Direct November2013
[7] Feyza Akarslan, "Solar-Energy Drying Systems, Modeling and Optimization of Renewable Energy Systems", ISBN: 978-953-51-0600-5, May, 2012.
[8] A.R. Umayal Sundariet al., "Performance of Evacuated Tube Collector Solar Dryer with and Without Heat Sources", Iranica Journal of Energy & Environment 4 (4) 2013
[9] S. Babu Sasi et al., "experimental study on the thermal efficiency of the forced Convection evacuated tube solar air collectors with and without absorber plate", Jr. of Industrial Pollution Control 2018.
[10] P.Vijayakumar, et al., "Comparison of evacuated tube and flat plate solar collector'', WWJMRD 2017.
[11] Manoj Kumar Gaur et al. "Recent Development and Applications of Evacuated Tube Solar Collectors", STGSF 2017.
[12] M.A. Sabiha et al., "Progress and latest developments of evacuated tube solar collectors", Renewable and Sustainable Energy Reviews 51 2015.
[13] Chandraprabu Venkatachalam et al., "Evacuated Tube Solar Collectors", International Journal of Scientific Engineering and Research (IJSER) 2017.
[14] Ashish Kumar et al., "Experimental Study of Thermal Performance of One-Ended Evacuated Tubes for Producing Hot Air", Hindawi Publishing Corporation,Journal of Solar Energy November 2013.
[15] Avadhesh Yadav et al., "An Experimental Study on Evacuated Tube Solar Collector for Heating of Air in India", International Journal of Mechanical and Mechatronics Engineering 2011.
[16] S. P. Sukhatme and J. P. Nayak - Solar Energy. Tata McGraw-Hill Publishing conmany.