International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

ANALYSIS OF SOLAR DRYING SYSTEM FOR THE APPLICATIONS LIKE FRUITS AND VEGETABLES. (GREEN PEAS AND RAISINS)

Kamesh D. Katare[1], Pratik M. Jadhav[1], Adrash B. Dhakoliya[1], Tanmay J. Joshi[1], Mr. Pratap Ramesh Sonawane[2]

[1]*Student MCOERC Nasik*
[2]*Asst. Prof. MCOERC Nasik*

ABSTRACT

In many countries of the world, the use of solar thermal system in the agricultural area to preserve vegetables, fruits, coffee and other corps has shown to be practical, economical and the responsible approach environmentally. The solar drying system utilizes the solar energy to heat up a air and to dry any food substance which is loaded, which is not only beneficial but also it reduces wastage of agricultural products and helps in preservation of agricultural products. We are going to do an analysis of the parameters that are concerned with cost and efficiency of solar dryer. We are also going to make a design of solar dryer which would be having a critical low cost or have less cost/kg for drying and maximum efficiency by varying some parameters.

1. INTRODUCTION

Solar drying is the most common method for preserving food and extending the shelf life of agricultural produce. It is a simultaneous heat and mass transferoperation in which moisture is removed from food material and carried out using hot air. Solar dryers can be used for industrial and domestic drying processes. It isa useful device for energy conservation, saves drying time, minimizes drying area and enhances the quality of dried product, with reduced carbon emission CO benefits. It is a key element in powering agriculture through reduction of postharvest losses and preparing agricultural products for secondary processing Solar drying of orange fresh sweet potatoes is a proven practice with dryer designs that are tailored to meet the drying requirements of this crop. Simulation models exist for designing, construction and operating the drying systems. Economic analysis for an indirect type solar fruit and vegetable dryer by various authors stress the most significant economic parameters in the lifecycle costing of the system as the payback period and internal rate of return.

2. LITERATURE REVIEW

Some research effort to design and develop a forced convection solar dryer using evacuated tube air collector. Their performance was compared with natural sun drying. The results of the present study show that the proposed solar dryer has been greater efficiency, and the moisture content of bitter gourd is reduced from 91% to 6.25% in 6 hours as compared to 10 hours in natural sun drying [1]. Another work studies an experimental study was conducted to investigate the performance of a solely solar drying system and a system equipped with an auxiliary heater as a supplement to the solar heat, [2]. The performances of both are compared to that of natural drying. Beans and peas are dehydrated in a system that consists of two flat plate collectors, a blower, and a drying chamber. Tests with four different airflow rates, namely, 0.0383, 0.05104, 0.0638, and 0.07655 m3 /s were conducted. The efficiency of the mixed drying system was found to increase by 25% to 40% compared to the solely solar drying. A best fit to the experimental data of peas and beans was obtained by six exponential equations for the various systems with a correlation coefficient in the range 0.933 and 0.997. Solar drying can be an effective means of food preservation since the product is completely protected during drying against rain, dust, insects and animals [3]. There is a great diversity of designs and modes of operation: forced convection, Ahmad et al., [4], Indirect forced convection, Bahlou et al., [5], Direct cabinet and indirect cabinet solar dryers, Banoult et al., [6], Solarbiomass hybrid dryer enhanced by the Co-Gen technique, Tadahmun and Hussai, [7]; Leon and Kumar, [8], Greenhouse solar dryers, Abdullah, [9]; Bechoff et al., [10], Direct solar dryer, Hii et al., [11], Heat pumps, Fadhel et al., [12]; Li et al., [13], Indirect natural convection solar dryer with chimney, solar dryer with greenhouse as collector, solar tunnel dryer (air collector), hybrid solar dryer assisted by evacuated tube collectors, Jairaj et al., [14]. F. Chabane & al [15-26], Presents a study of heat transfer in a solar air heater by using new design of solar collector. The collector efficiency in a single pass of solar air heater without, and with using fins attached under the absorbing plate has been investigated experimentally the maximum efficiency obtained for the 0.012 and 0.016 kg/s with, and without fins were 40.02, 51.50% and 34.92, 43.94%.

3. SOLAR DRYER

The classifications of sun drying procedures are created based on the stage of processing, the location of drying or the apprehension to solar radiation. The solar dryers can broadly be classified into six broad types open drying, direct solar dryer, indirect solar dryer, mixed mode solar dryer, natural convection solar dryer (passive mode), forced convection solar dryer (active mode solar dryer).

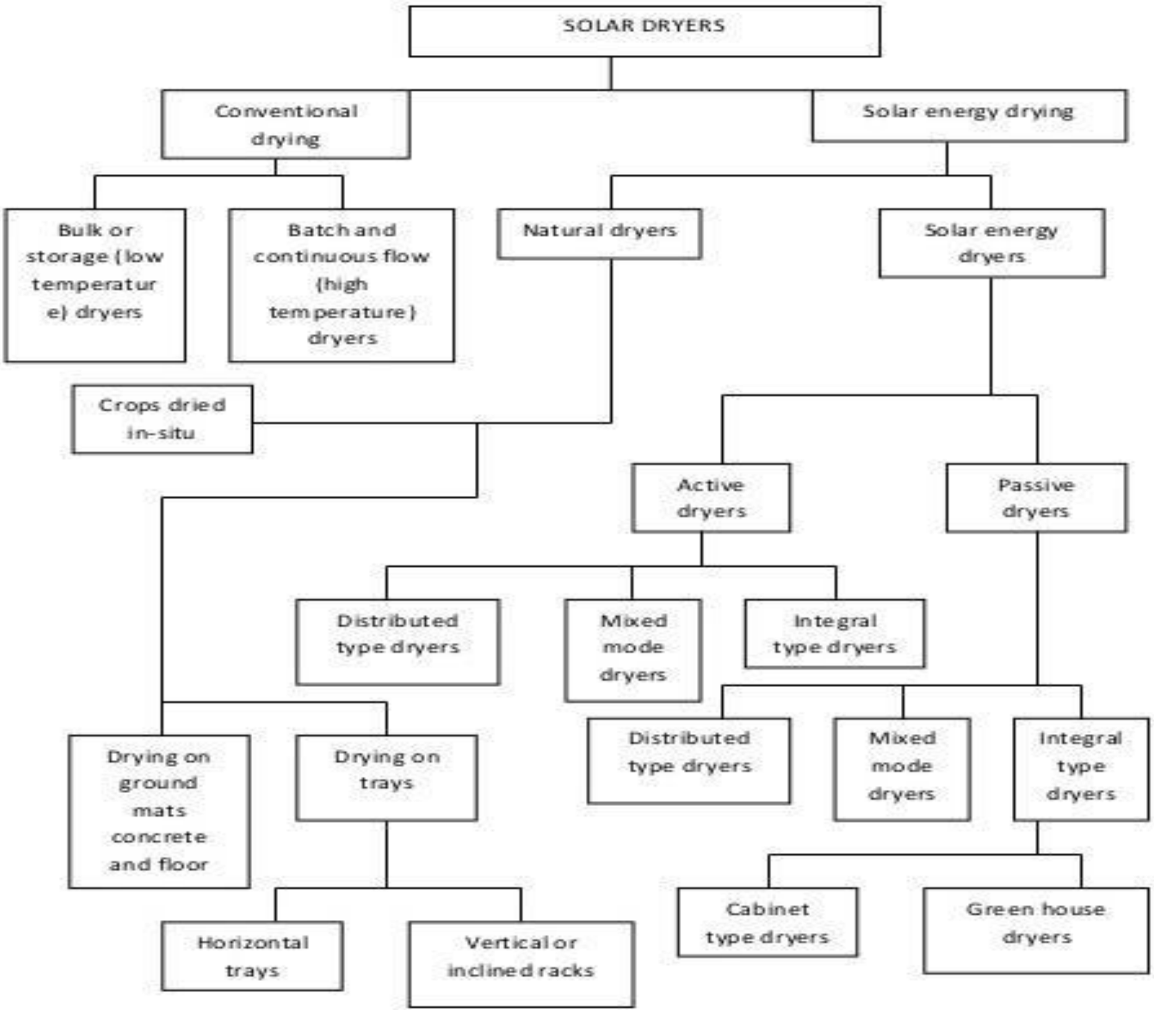


Fig.1 Classification of Solar Dryers

4. PARAMETERS THAT ARE CONCERNED WITH SOLAR DRYER

Following are the important parameters that are concerned with solar drying system.

1. Temperature
2. Humidity
3. Velocity of air
4. Solar collector area
5. Sunshine hours
6. Pressure drop between inlet and outlet of air flow.
7. Drying Force
8. Constructional material

9. Sun radiation

10. Air flow rate

Observation:- We took reading for one week (6 day) reading for the average time period of 9am to5pm and found out following readings,

Product Name: Raisin.

Initial Weight (Wi): 8000 gm.

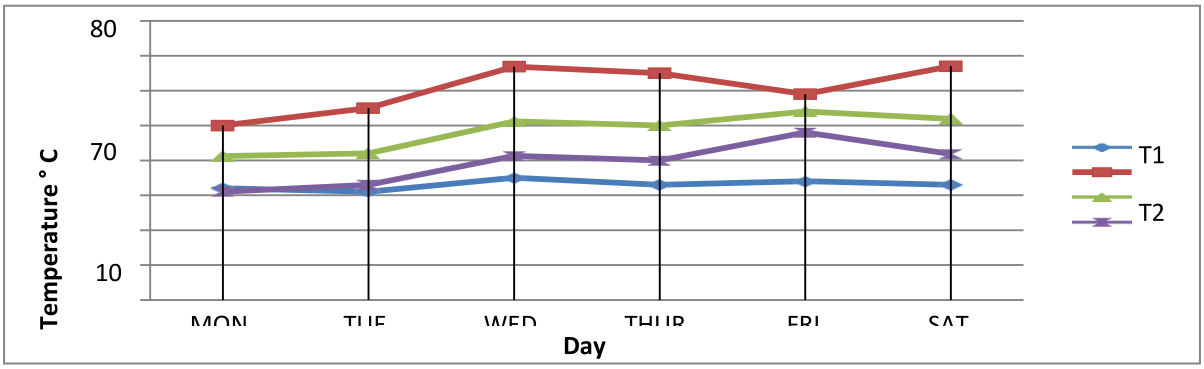
Table 5: Readings of Raisin

Sr No.	Day	Temperature			
		T1	T2	T3	T4
01	MON	32	50	41.2	31
02	TUE	31	55	42	33
03	WED	31	66.9	51.2	41.3
04	THUR	33	65	50	40
05	FRI	33	59	54	48
06	SAT	33	67	51.9	41.8

Temperature Readings of Solar Dryer:

T1 = Inlet temperature of Solar collector. T2 = Outlet temperature of Solar Collector.T3 = Inlet temperature of Drying Chamber.

T4 = Outlet temperature of Drying Chamber.



Graph.1 Temperature Variation in Inlet and Outlet of Solar Collector and Drying Cabinet

Initial Weight (Wi): 8000 gm.

Final Weight (Wf): 7000 gm. Weight Loss in 8 Hrs. = Wi–Wf
= 8000 – 7000

= 1000 gm.

Product Name: Green Peas.

Initial Weight (Wi): 5415 gm.

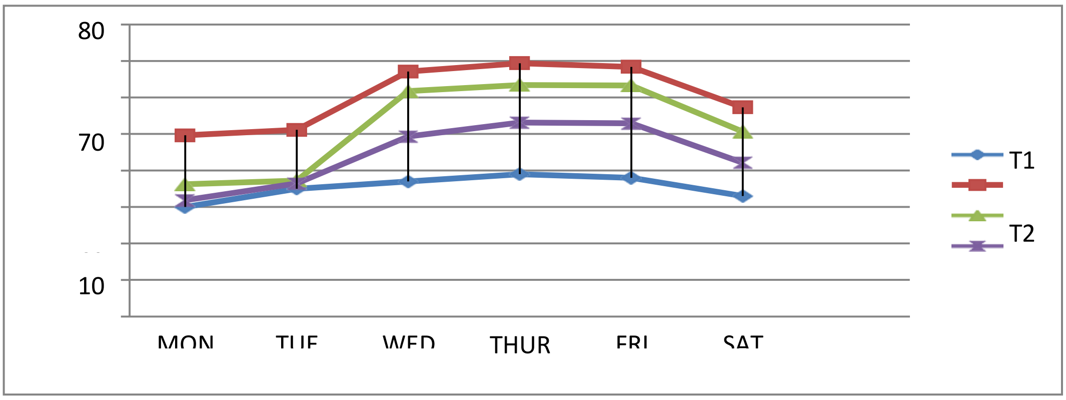
Table 6: Readings of Green Peas

Sr No.	Day	Temperature			
		T1	T2	T3	T4
01	MON	30	49.6	36.2	31.8
02	TUE	35	51.1	37.2	36.4
03	WED	37	67.1	61.7	49.3
04	THUR	39	69.4	63.4	53.1
05	FRI	38	68.4	63.3	52.9
06	SAT	33	57.3	50.6	42.1

Initial Weight (Wi): 5415 gm.

Final Weight (Wf): 4742gm. Weight Loss in 8 Hrs. = Wi–Wf= 5415 – 4742

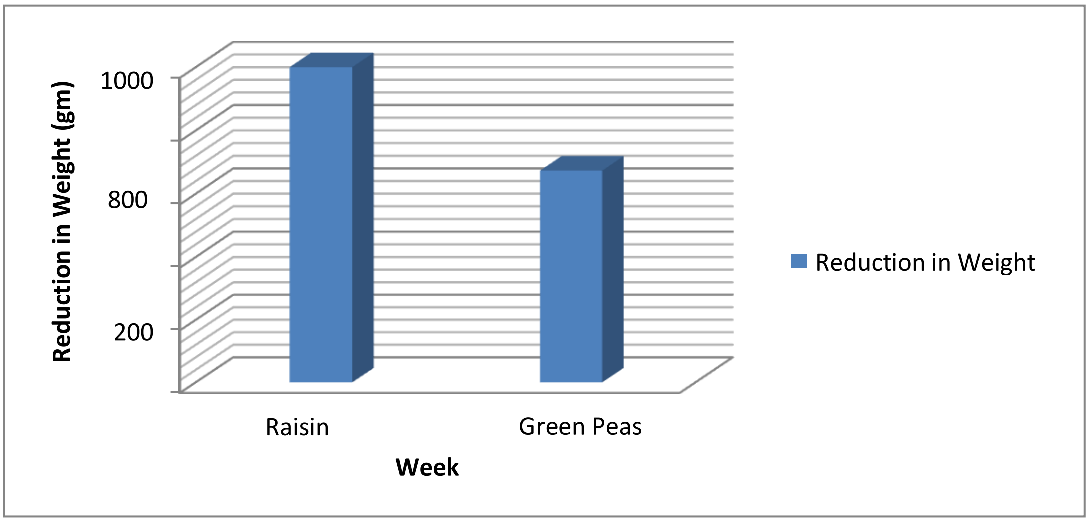
= 673 gm.



5. RESULT

Graph.2 Temperature Variation in Inlet and Outlet of Solar Collector and DryingCabinet

Sr No.	Initial Weight (in gm)	Final Weight (in gm)	Reduction in Weight (in gm)
01	8000	7000	1000
02	5415	4742	673



Graph.3 Variation of Reduction in Weight in 8 Days.

6. CONCLUSION

1. The reduction in drying occurs by increasing air flow rate.
2. The food items are also well protected in the solar dryer than in the open sun, thus minimizing the case of pest and insect attack and also contamination.
3. Although the dryer was used to dry it can be used to dry Raisin and Green Peas other crops like spinach, soyaben vadi onions, potatos and chili etc.
4. The capital cost involved in the construction of a solar dryer is much lower to that of a mechanical dryer and the running cost is negligible.
5. The reduction in drying time of onions by forced convection is 22.2 % compared to natural convection.
6. Forced convection solar dryer is more suitable to reduce drying time and helps in producing high quality of dried sample.

REFERENCES

[1] Umayal Sundari AR, Neelamegam P, Subramanian CV. (2013). An experimental study and analysis on solar drying of bitter gourd using an evacuated tube air collector. Conference Papers in Energy, Thanjavur, Tamil Nadu, India.

[2] Khalifa AJN, Al-Dabagh AM, Al-Mehemdi WM. (2012). An experimental study of vegetable solar drying systems with and without auxiliary heat. ISRN Renewable Energy 2012, Article ID 789324, 8 pages. http://dx.doi.org/10.5402/2012/789324

[3] Esper A, Muhlbauer W. (1998). Solar drying –an effective means of food preservation. Renew Energy 15(1–4): 95–100. https://doi.org/10.1016/S0960- 1481(98)00143-8

[4] Ahmad F, Kamaruzzaman S, Mohammad HY, Mohd HR, Mohamed G, Hussein AK. (2014). Performance analysis of solar drying system for red chili. Sol. Energy 99: 47–54. https://doi.org/10.1016/j.solener.2013.10.019

[5] Bahloul N, Boudhrioua N, Kouhila M, Kechaou B. (2009). Effect of convective solar drying on colour, total phenols and radical scavenging activity of olive leaves (Olea europaea L). Int. J. Food Sci. Technol. 44(12): 2561–2567. https://doi.org/10.1111/j.1365- 2621.2009.02084.x

[6] Banout J, Havlik J, Kulik M, Kloucek P, Lojka B. (2010). Effect of solar drying on the composition of essential oil of sacha culantro (Eryngium foetidum L) grown in the peruvian amazon. J. Food Process. Eng. 33(1): 83–103. https://doi.org/10.1111/j.1745-4530.2008.00261.x

[7] Tadahmun AY, Hussian HA. (2016). Experimental investigation and evaluation of hybrid solar/termal dryer combined with supplementary recovery dryer. Sol. Energy 134: 284–293. https://doi.org/10.1016/j.solener.2016.05.011

[8] Leon MA, Kumar S. (2008). Design and performance evaluation of a solar assisted biomass drying system with thermal storage. Dry Technol. 26(7): 936–947. https://doi.org/10.1080/07373930802142812

[9] Abdullah K. (1997). Drying of vanilla pods using a greenhouse effect solar dryer. Dry Technol. 15(2): 685– 698. https://doi.org/10.1080/07373939708917254

[10] Bechoff A, Dufour D, Dhuique-Mayer C, Marouzé C, Reynes M, Westby A. (2009). Effect of hot air, solar and sun drying treatments on provitamin a retention in orange- fleshed sweet potato. J. Food Eng. 92(2), 164– 171. https://doi.org/10.1016/j.jfoodeng.2008.10.034

[11] Hii CL, Abdul Rahman R, Jinap S, Che Man YB. (2006). Quality of cocoa beans dried using a direct solar dryer at different loadings. J. Sci. Food Agri. 86(8): 1237–1243. https://doi.org/10.1002/jsfa.2475 [12] Fadhel MI, Sopian K, Daud WRW, Alghoul MA. (2010). Performance analysis of solar-assisted chemical heat-pump dryer. Sol. Energy 84: 1920–1928. https://doi.org/10.1016/j.solener.2010.07.001

[12] Li Y, Li HF, Dai YY, Gao SF, Wei L, Li ZL, Odinez IG, Wang RZ. (2011). Experimental investigation on a solar assisted heat pump in-store drying system. Appl. Thermal Eng. 31(10): 1718–1724. https://doi.org/10.1016/j.applthermaleng.2011.02.014

[13] Jairaj KS, Singh SP, Srikant K. (2009). A review of solar dryers developed for grape drying. Sol. Energy 83(9): 1698–1712. https://doi.org/10.1016/j.solener.2009.06.008

[14] Chabane F, Moummi N, Benramache S, Bensahal D, Belahssen O. (2013). Collector efficiency by single pass of solar air heaters with and without using fins. Engineering Journal 38(1): 44-53. https://doi.org/10.1016/j.icheatmasstransfer.2010.09.01 5

[15] Chabane F. (2014). Noureddine moummi, said benramache, heat transfer and energy analysis of a solar air collector with smooth plate. The European Physical Journal Applied Physics 66(1): 10901.

[16] Chabane F, Hatraf N, Moummi N. (2014). Experimental study of heat transfer coefficient with rectangular baffle fin of solar air heater. Frontiers in Energy 8(2): 160-172.

[17] Chabane F, Moummi N, Bensahal D, Brima A. (2014). Heat transfer coefficient and thermal losses of solar collector and Nusselt number correlation for rectangular solar air heater duct with longitudinal fins hold under the absorber plate. Applied Solar Energy 50(1): 19-26.

[18] Chabane F, Moummi N, Benramache S. (2014). Experimental study of heat transfer and thermal performance with longitudinal fins of solar air heater. Journal of Advanced Research 5(2): 183–192. https://doi.org/10.1016/j.jare.2013.03.001

[19] Chabane F, Moummi N, Brima A, Benramache S. (2013). Thermal efficiency analysis of a single-flow solar air heater with different mass flow rates in a smooth plate. Frontiers in Heat and Mass Transfer 4(1).

[20] Chabane F, Moummi N, Benramache S, Bensahal D, Belahssen O. (2013). Effect of artificial roughness on heat transfer in a solar air heater. Journal of Science and Engineering 1(2): 85-93.

[21] Chabane F, Moummi N, Benramache S. (2013). Experimental analysis on thermal performance of a solar air collector with longitudinal fins in a region of Biskra, Algeria. Journal of Power Technologies 93(1): 52-58.

[22] Chabane F, Moummi N, Benramache S, Lemmadi FZ. (2013). Thermal performance optimization of a flat plate solar air heater. International Journal of Energy & Technology 5(8): 1-6.

[23] Chabane F, Moummi N, Benramache S. (2012). Experimental study on heat transfer for a solar air heater and contribution the fins to improve the thermal efficiency. International Journal of Advanced Renewable Energy Researches 1(9).

[24] Chabane F, Moummi N, Benramache S. (2012). Experimental performance of solar air heater with internal fins inferior an absorber plate: In the region of Biskra. International Journal of Energy & Technology 33(4): 1-6.

[25] Chabane F, Moummi N, Benramache S. (2012). Effect of the tilt angle of natural convection in a solar collector with internal longitudinal fins. Journal of Science and Engineering Investigations 1: 13-17.