Comparative overview of performance of the dryers with a conventional method of drying i.e., open sun drying

Abstract

Since ancient times, conventional techniques of food drying, such as sun drying, have been used. Currently, drying methods have been developed with the latest technology to reduce the damages caused by biochemical changes, which decrease nutritional value during the drying process. Some of the typical drying methods used for food products are sun drying, solar tunnel dryer, cabinet-type solar drying, etc. While this is going on, cutting-edge technology is being created to combine several drying techniques to produce the optimum outcomes. The most recent drying techniques used in food processing technology will be covered in this study.

Keywords: Food drying, Techniques, Damages, Solar tunnel drying, Cabinet type solar drying, Combinations.

1. Introduction:

"Food spoilage refers to irreversible changes where food becomes inedible or its quality is dangerous"**(Rawat, 2015)**."Preservation of fruits, vegetables, and food is essential for keeping them for a long time without further deterioration in the quality of the product. Several process technologies have been employed on an industrial scale to preserve food products; the major ones are canning, freezing, and dehydration. Drying is especially suited for developing countries with poorly established low-temperature and thermal processing facilities. It offers a highly effective and practical means of preservation to reduce post-harvest losses and offset the shortages in supply"(Badgujar et al., 2018). "Drying is a simple process of moisture removal from a product to reach the desired moisture content and is anenergy-intensive operation. The prime objective of drying apart from extended storage life can also be quality enhancement, ease of handling, further processing and sanitation and is probably humankind's oldest method of food preservation" [4-7]. "Drying involves the application of heat to vaporize moisture and some means of removing water vapor after its separation from the food products. It is thus a combined and simultaneous heat and mass transfer operation for which energy must be supplied" [8-10]."Removingmoisture prevents the growth and reproduction of microorganisms like bacteria, yeasts, and molds, causing decay and minimizes many of the moisture-mediated deteriorative reactions. It substantially reduces weight and volume, minimizing packing, storage, and transportation costs and enables product storability under ambient temperatures. These features are essential for developing countries in military feeding and space food formulations"**(Visavale, G.L., 2012)**.

2. Materials and Methods:

This studydeals with the description of various materials and methods used to accomplish the research work done to attain the desired objectives.The samples were collected from the Khan Chauraha market, Maheva, and Naini in Prayagraj. The samples were collected from different shopkeepers to obtain maximum variation in the quality; as a result, the different dryers may be used to dry the different vegetables.

Climatic conditions were studied inside the solar tunnel dryer. Mainly weather conditions were studied for achieving the good thermal efficiency and drying rate of the dryer. The weather conditions include:

- Temperature variations inside and outside the solar tunnel dryer (°C)
- Solar radiation inside and outside the tunnel dryer (w/m2)

The solar tunnel dryer or cabinet-type solar dryer was tested in the FMP department during the winter season in October to November 2021 and in summer season from April 2022 to May. The sample was loaded in the solar tunnel dryer and cabinet-type solar dryer trays in equal amounts. The experiments were done with a fan speed of 1 m/s.

The cost of the solar tunnel dryer was calculated based on the amount of materials used and the estimated cost incurred in the fabrication of the solar tunnel dryer. The solar tunnel dryer's total cost was determined based on fixed and variable cost. The cost of operation obtained was compared with the sun drying (Badgujar et al 2019).

3. Results and Discussion:

Data illustrated in Table 1 shows the data regarding the sample weight of different leaves in different weather i.e., winter and summer.

3.1 Moisture content:

3.1.1 Mint Leaves: Decreasing water content from 13.18% (wb) to 10.4% (wb) in solar tunnel dryer in winter and summer, followed by decreasing water content from 16.80% (wb) to 12.81% (wb) in cabinet solar dryer in winter and summer and decreasing water content from 19.24% (wb) to 7.6% (wb) in open sun dryer in winter and summer.

3.1.2 Potato Chips: Decreasing water content from 21.28% (wb) to 16.73% (wb) in solar tunnel dryer in winter and summer followed by decreasing water content from 27.58% (wb) to 4.36% (wb) in cabinet solar dryer in winter and summer and decreasing water content from 15.83% (wb) to 31.86% (wb) in open sun dryer in winter and summer.

3.1.3 Green Chili: Decreasing water content from 16.73% (wb) to 9.94% (wb) in solar tunnel dryer in winter and summer followed by decreasing water content from 17.00% (wb) to 13.07% (wb) in cabinet solar dryer in winter and summer and decreasing water content from 34.30% (wb) to 16.18% (wb) in open sun dryer in winter and summer.

Table 1: Sample Weight

Sr. No.	CROP (Sample)	MOIST SAMPLE WEIGHT (g)						DRIED SAMPLE WEIGHT (g)					
		SOLAR TUNNEL DRYER		CABINET TYPE SOLAR DRYER		OPEN SUN DRYING		SOLAR TUNNEL DRYER		CABINET SOLAR DRYER		OPEN SUN DRYING	
		winter	Summer	winter	winter	winter	winter	winter	summer	winter	summer	winter	summer
1	Mint Leaves	1200	1200	600	600	150	150	158.24	124.8	100.84	76.87	28.87	11.40
2	Potato Chip	6000	6000	3000	3000	750	750	1277.28	1004	827.6	131	118.75	239.58

	s												
3	**Green Chili**	6000	6000	3000	3000	750	750	1004	596.80	510.16	392.12	257.30	121.40

3.2 Thermal Efficacy: Data given in Table 2 represents the thermal efficacy of different samples.

3.2.1 Mint Leaves: Thermal efficacy of mint leaves varied between 40.04 and 44.68 at solar tunnel dryer; meanwhile, thermal efficacy of mint leaves varied between 34.46 and 40.38 at cabinet type solar dryer.

3.2.2 Potato Chips: Thermal efficacy of potato chips varied between 78.14 and 93at solar tunnel dryer meanwhile, the thermal efficacy of potato chips varied between 74.44 and 84.45at a cabinet type solar dryer.

3.2.3 Green Chili: Thermal efficacy of green chili varied between 49.34 and 82.94 at solar tunnel dryer;meanwhile, the thermal efficacy of green chili varied between 43.38 and 69.31 at cabinet type solar dryer.

Table 2: THERMAL EFFICIENCY

Sr. No.	CROP	SOLAR TUNNEL DRYER		CABINET-TYPE SOLAR DRYER	
		WINTER SEASON	SUMMER SEASON	WINTER SEASON	SUMMER SEASON
1	Mint Leaves	40.04	44.68	34.46	40.38
2	Potato Slices	78.14	93	74.44	84.45
3	Green Chili	49.34	82.94	43.38	69.31

3.3 Drying Efficacy: Data presented in Table 3shows the drying efficacy of different samples.

3.3.1 Mint Leaves: Drying efficacy of mint leaves varied between 21.84 and 34.14 at solar tunnel dryer meanwhile, drying efficacy of mint leaves varied between 20.92 and 32.60 at cabinet type solar dryer.

3.3.2 Potato Chips: Drying efficacy of potato chips varied between 44.99 and 49.69 at solar tunnel dryer meanwhile, the drying efficacy of potato chips varied between 39.47 and 43.55 at cabinet type solar dryer.

3.3.3 Green Chili: Drying efficacy of green chili varied between 36.72 and 42.29 at solar tunnel dryer meanwhile, drying efficacy of green chilivaried between 30.11 and 37.39 at cabinet type solar dryer.

Table 3: DRYING EFFICIENCY

Sr. No.	CROP	SOLAR TUNNEL DRYER		CABINET TYPE SOLAR DRYER	
		WINTER SEASON	SUMMER SEASON	WINTER SEASON	SUMMER SEASON
1	Mint Leaves	21.84	34.14	20.92	32.60
2	Potato Slices	44.99	49.69	39.47	43.55
3	Green Chili	36.72	42.29	30.11	37.39

4. Summary and Conclusion:

Food drying has several methods: sun drying, solar tunnel drying, cabinet type solar dryer, spray drying, drum drying, freezing, microwave drying, fluidized bed drying. The best drying technique is being developed through technology and research to generate high-quality dry goods while using less energy. Some of the technologies often used include mixed/hybrid drying methods, superheated steam drying, refractory window, impingement drying, high-electric field drying, electrohydrodynamic drying using electrotechnology, and ohmic drying.

References:

1. Rawat, S. (2015). Food Spoilage: Microorganisms and their prevention. *Asian J. Plant Sci. Res.* 5(4): 47–56.
2. Badgujar, C.M., Karpe, O., & Kalbande, S. (2018). Techno-economic evaluation of solar tunnel dryer for drying of basil (Ocimum sanctum). International Journal of Current Microbiology & Applied Sciences, 7(7), 332–39. https://doi.org/10.20546/ijcmas.2018.707.040
3. Badgujar, C. M, Karpe, O. S., & Kalbande, S. R. (2019). Studies on drying characteristics & techno-economic analysis of sprouted moth beans

(VignaAconitifolia) in solar tunnel dryer. Indian Journal of Agricultural Research. https://doi.org/10.18805/A-5180

4. Sreekumar A, Manikantan PE, Vijayakumar KP. Performance of indirect solar cabinet dryer. Energy Conversion and Management. 2008 Jun 1;49(6):1388-95.
5. Sharma A, Sharma N. Construction and performance analysis of an indirect solar dryer integrated with solar air heater. Procedia Engineering. 2012 Jan 1;38:3260-9.
6. Mustayen AG, Mekhilef S, Saidur R. Performance study of different solar dryers: A review. Renewable and Sustainable Energy Reviews. 2014 Jun 1;34:463-70.
7. Rathore NS, Panwar NL. Experimental studies on hemi cylindrical walk-in type solar tunnel dryer for grape drying. Applied Energy. 2010 Aug 1;87(8):2764-7.
8. El-Sebaey MS, Mousavi SM, El-Din SS, Essa FA. An experimental case study on development the design and the performance of indirect solar dryer type for drying bananas. Solar Energy. 2023 May 1;255:50-9.
9. Iranshahi K, Rubinetti D, Onwude DI, Psarianos M, Schlüter OK, Defraeye T. Electrohydrodynamic drying versus conventional drying methods: A comparison of key performance indicators. Energy Conversion and Management. 2023 Mar 1;279:116661.
10. Shimpy, Kumar M, Kumar A. Designs, performance and economic feasibility of domestic solar dryers. Food Engineering Reviews. 2023 Mar;15(1):156-86.