

Cite this article: D. Chhaiya, N. Patel, Influence of ambient and operational parameters on hot-air drying of fruits and vegetables in a tray dryer: A review, *RP Cur. Tr. Agri. Env. Sci.* 4 (2025) 1–7.

## Review Article

# Influence of ambient and operational parameters on hot-air drying of fruits and vegetables in a tray dryer: A review

Devat Chhaiya\*, Nikunj Patel

Department of Mechanical Engineering, Sardar Vallabhbhai National Institute of Technology, Ichchhanath, Surat-395007, Gujarat, India

\*Corresponding author, E-mail: [chhaiyadevat@gmail.com](mailto:chhaiyadevat@gmail.com)

## ARTICLE HISTORY

Received: 10 April 2026

Revised: 27 May 2026

Accepted: 27 May 2026

Published online: 17 June 2026

## KEYWORDS

Hot-air drying; Drying parameters; Energy consumption; Fruits and vegetables.

## ABSTRACT

India is the world's second-largest producer of fruits and vegetables after China; however, a significant portion of this produce is lost between harvest and consumption due to inadequate storage facilities, limited post-harvest practices, and technological limitations. Drying is widely employed to extend shelf life by reducing moisture content through combined heat and mass transfer, although it is an energy-intensive process. This paper presents a critical review of performance-influencing parameters in hot-air drying systems, including ambient air temperature and relative humidity (RH), drying air temperature, air velocity, slice thickness, tray porosity and exhaust air recirculation. The influence of these parameters on drying rate and energy consumption is discussed based on available literature. Major trends and optimal ranges such as drying air temperature of 50 - 70 °C, air velocity of 2 - 3 m/s and slice thickness of 2 - 7 mm are identified, along with research gaps for future dryer design.

## 1. Introduction

Fruits and vegetables are essential to global nutrition and food security, offering vital micronutrients and fostering dietary variety [12]. The production of fruits and vegetables is increasing steadily worldwide due to population growth, increased health awareness, and continuous improvements in farming and processing technologies [10]. India ranks second in the production of both fruits and vegetables after China, with horticultural production estimated at around 367.72 million tonnes in the 2023-24 fiscal year [17]. Although India is a key producer of fruits and vegetables, it faces a significant challenge in the form of post-harvest losses. Approximately 30-40% of fruits and vegetables are lost between harvest and consumption due to inadequate storage infrastructure, limited post-harvest handling knowledge, and technological gaps [19]. This huge loss of fruits and vegetables is further accelerated due to the spoilage due to initial high moisture content. If this moisture content is reduced by some means, then this huge loss of fruits and vegetables can be reduced. One of the effective methods for reducing this moisture content is drying [21]. Drying is the process of reducing moisture content of a substance through simultaneous heat and mass transfer, primarily used for long-term preservation. The drying process is energy-intensive and requires continuous heat supply and airflow to effectively remove water content from the product. [2]. A variety of environmental and operational factors dictate the efficiency of the drying process. These include atmospheric properties, such as ambient temperature and humidity, in addition to operational settings - including drying air temperature, airflow velocity, and exhaust air recycling - and

structural variables like tray porosity and slice thickness [8],[22],[26],[28]. The rate of drying and consumption of energy during drying process is strongly influenced by the above-mentioned parameters. Therefore, current work aims to critically review and synthesize existing works to clarify the influence of essential drying variables on processing speed and power consumption in hot-air tray drying system. The outcome of this analysis is expected to provide a structured reference and guidance for future researchers working on dehydration of agricultural produce.

## 2. Methodology of review

A literature survey was carried out using widely used academic search engines and databases to collect journal articles and conference papers related drying of fruits and vegetables using heated air. The search was performed using combinations of keywords such as heated air drying, tray dryer, fruits and vegetables, drying rate, energy consumption, and ambient conditions. Studies published mainly between 2016 and 2025 were considered to show the recent developments. To maintain a specific scope, the analysis was restricted to investigations regarding the impact of ambient and operational parameters - specifically drying air temperature, air velocity, and exhaust recirculation - alongside structural variables like tray porosity and slice thickness, on drying kinetics and power requirements. Studies focusing on other drying techniques or non-food materials were excluded.

A conceptual layout of hot air-drying system utilized for agricultural crops is presented in Fig. 1.



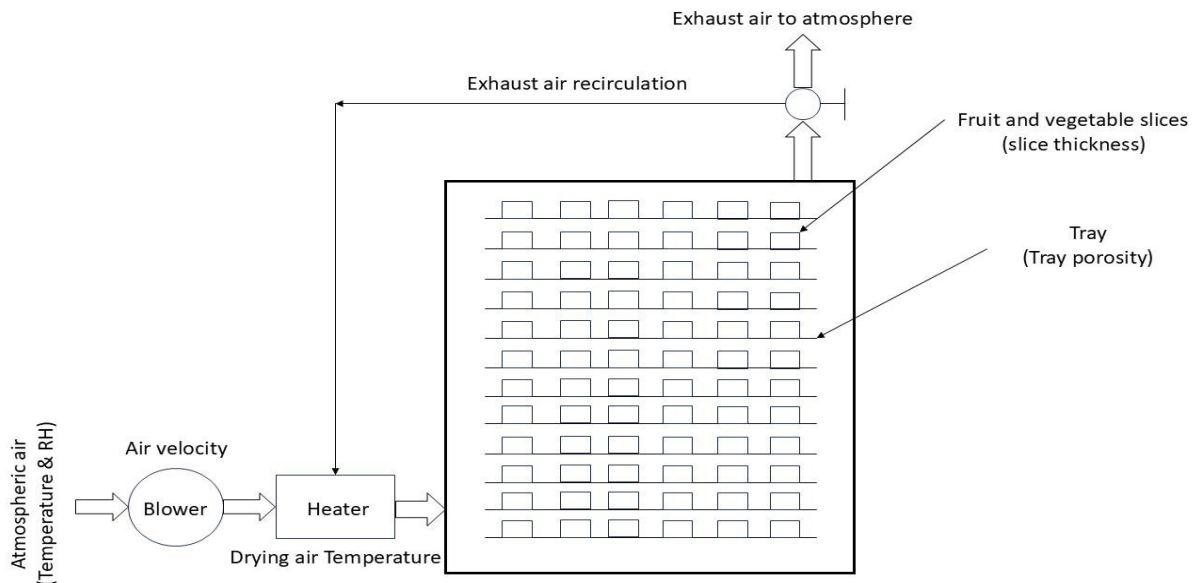


Figure 1: Conceptual layout of hot air-drying system.

### 3. Influence of ambient and operational parameters on hot-air drying system

#### 3.1 Effect of ambient temperature and relative humidity

Ambient air properties - specifically temperature and RH - act as the main drivers for the drying of agricultural produce. These variables control the driving force for mass transfer by altering the vapor pressure at the product-air interface. As a result, the overall drying performance and energy profile of the system are basically linked to the initial state of the surrounding atmosphere.

Davidsson et al. [3] identified that ambient RH is a main factor in drying kinetics; even with intense solar radiation, increased humidity levels slow the process, causing asynchronous drying rates between the inlet and outlet sections of the tray dryer. Noori et al. (2021) [13] also reported similar findings that drying rates are higher at low relative humidity and high temperatures, whereas an increase in relative humidity during evening hours may lead to partial rehydration of the product. Ruzikulov et al. (2023) [20] reported that increases in ambient temperature and solar radiation elevates

the internal drying chamber temperature (up to 46 °C), thereby reducing drying time by 1.5-2 times compared with open-air drying while improving moisture removal efficiency. Similarly, Olmos-Cruz et al. (2025) [16] also showed that ambient temperature and relative humidity strongly affect drying rate and energy efficiency, and under favourable conditions the drying time can decrease by up to 40%, while the drying efficiency can reach up to 58.2%.

This review indicates that ambient conditions strongly affect drying performance. Relative humidity acts as a crucial controller of the drying process by determining the driving force for evaporation. Specifically, it influences the equilibrium moisture content and the speed at which the concentration gradient allows water to escape the product surface. In contrast, ambient temperature mainly affects the energy requirement by reducing the energy input needed to keep the chamber temperature. Fig. 2 represents the conceptual framework of how relative humidity serves as a important determinant for drying performance and energy efficiency, as derived from existing studies.

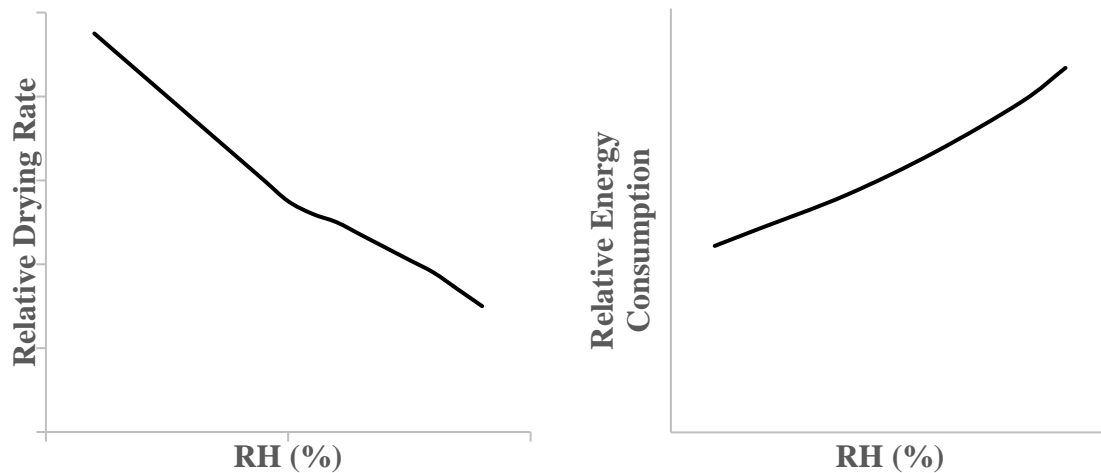


Figure 2: Conceptual influence of relative humidity (RH) of ambient air on drying rate and energy consumption in hot air-drying system based on trends observed in the literature.

**Table 1:** Effect of ambient temperature and relative humidity on drying rate and energy consumption in hot air-drying system.

Author (Year)	Product	Key ambient variable	Effect on drying rate	Effect on energy consumption
Davidsson et al. (2017)	Tangerine, orange	Air temperature, RH, airflow conditions	High RH and cool wind reduced drying flux	-
Noori et al. (2021)	Mint leaves	T ~ 20-30 °C; RH 14 ~ 28.8 %	Low RH and high temperature improve the drying rate	Dry climate enabled operation using only solar-powered fans
Ruzikulov et al. (2023)	Apple, apricot	Variable solar intensity and ambient temperature	Higher ambient temperature increased chamber temperature up to 46 °C, reducing drying time by 1.5-2 times	Solar energy supplied ~ 98.7 % of drying energy demand
Olmos-Cruz et al. (2025)	Tomato slices	Seasonal variation (T, RH, irradiance, wind speed)	Low RH and high temperature (summer) reduced drying time by up to 40%	Drying efficiency improved up to ~ 32%; better performance under low RH conditions

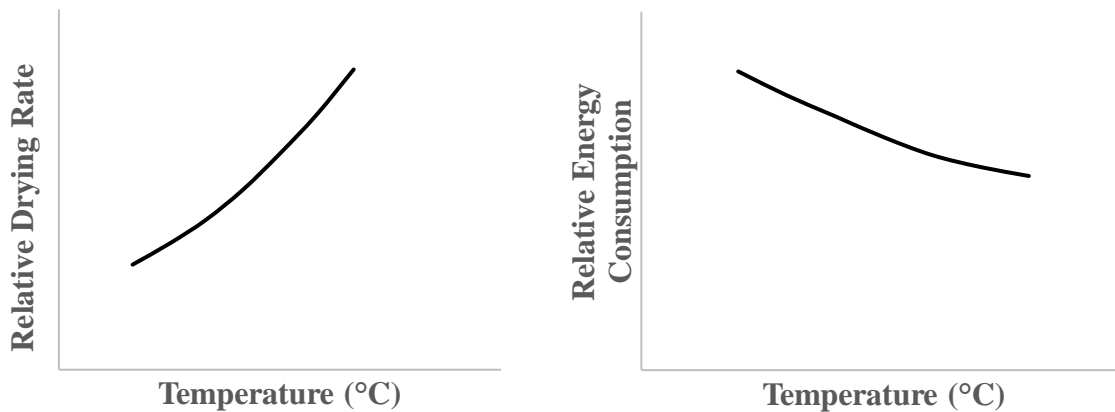
**3.2 Effect of drying air temperature**

The drying air temperature significantly dictates the efficiency of the process, specifically influencing internal moisture mobility and overall power requirements. While elevated temperatures enhance the driving force for evaporation - leading to shorter drying cycles - they are often accompanied by the thermal degradation of heat-sensitive compounds.

Tan et al. [25] reported that raising the process temperature from 50 °C to 70 °C improved moisture diffusivity and reduced drying time, leading to reduced total energy consumption. Lin et al. (2023) [9] similarly reported that raising drying temperature increased the drying rate of mango slices by accelerating the moisture removal rate, which consequently resulted in lower energy consumption per unit volume during the drying process. In a study on culture asparagus, Gökçe Kocabay et al. [7] observed that a thermal shift from 50 to 70°C accelerated the process significantly,

requiring only 510 minutes compared to the initial 1200 minutes. This adjustment proved energy-efficient, lowering the specific power demand from 81 to 34 kWh/kg. Hamed et al. (2025) [5] also observed that higher drying air temperatures improved moisture evaporation and diffusion, thereby shortening the drying time of *Opuntia dillenii* slices from 1080-1500 min to 660-840 min, depending on slice thickness.

From the above studies, the conceptual influence of thermal energy input on drying rate and energy consumption is shown in Fig. 3. Enhancing the thermal energy input improves moisture evaporation and diffusion; therefore, the drying rate increases and the processing duration is effectively compressed. This reduction in processing hours ultimately lowers the total energy consumption of the process. However, excessively high drying temperatures may negatively affect product quality and cause deterioration of thermally sensitive compounds. Therefore, an optimal drying temperature is required to balance energy consumption and drying efficiency.



**Figure 3:** Conceptual influence of drying air temperature on drying rate and energy consumption in hot air-drying system based on trends reported in the literature.

**Table 2:** Effect of drying air temperature on drying rate and energy consumption in hot air-drying system.

Author (Year)	Product	Temperature range	Effect on drying rate	Effect on energy consumption
Tan et al. (2022)	Blood-flesh peach	50-70 °C	Increasing temperature enhanced drying rate (falling-rate period); drying time significantly reduced with temperature	70 °C identified as optimal considering drying efficiency and product quality
Lin et al. (2023)	Mango slices	50-70 °C	Higher temperature accelerated moisture removal and reduced drying time	Energy consumption per unit volume decreased at higher temperatures
Gökçe Kocabay et al. (2024)	Culture asparagus	50-70 °C	Drying time reduced from 1200 to 510 min with temperature increase	Total energy consumption decreased from 10.14 to 4.31 kWh; higher temperature improved energy efficiency
Hamed et al. (2025)	<i>Opuntia dillenii</i>	50-70 °C	Faster moisture reduction; higher diffusivity	Improved drying efficiency under higher temperature conditions

### 3.3 Effect of drying air velocity

Air flow speed significantly affects drying kinetics and energy consumption by altering convective heat and mass transfer characteristics. An increase in air velocity generally enhances the drying rate by thinning the boundary layer around the product surface which in turn reduce the external resistance to moisture transfer.

Rajkumar et al. [18] examined how air flow speeds affect tomato slice processing, observing that lower velocities 2 m/s hindered the evaporation rate. Conversely, at an elevated speed of 4 m/s, the system’s performance declined because the air could not be sufficiently heated, showing a trade-off between airflow and heat transfer. The most effective drying kinetics were observed at a velocity of 3 m/s. This specific setting resulted in a moisture removal rate of 1.68 g/min, allowing dehydration to a final content of 7.1% within a 10-hour cycle. An experimental study by Moussa Na Abou et al. [11] on tomato slices revealed that elevating the air speed by 1 m/s (from 2 to 3 m/s) improved the dehydration kinetics by nearly 40%. This shift, from 0.0023 to above 0.0032 kg water/kg dry matter, was attributed to the superior heat and mass transfer efficiency at higher velocities. However, raising the air flow speed may also increase the energy demand required to drive

the airflow in the drying system. A notable reduction in processing duration was reported by Nurkhoeriyati et al. [14] during the dehydration of celeriac slices. By elevating the airflow speed from 1.5 to 2.9 m/s, the researchers achieved a significantly faster moisture removal rate, thereby accelerating the overall cycle; however, the energy demand also increased because of higher blower power requirements. El-Mesery (2022) [4] further demonstrated that increasing air velocity reduced the drying time; however, it also increased the energy requirement. This is because of the requirement of additional electrical energy to drive the blower at higher airflow rates.

Based on the above reviewed studies, the conceptual relationship between air velocity, drying rate, and energy consumption is illustrated in Fig. 4. it may be concluded that at low air velocity the drying rate is lower due to limited convective heat and mass transfer. In contrast, very high air velocity may reduce the air temperature due to insufficient heating of the incoming air. Therefore, an optimal air velocity of about 2-3 m/s is recommended for hot air-drying system, as it improves the drying rate, reduces drying time, and maintains a balance between drying performance and energy consumption.

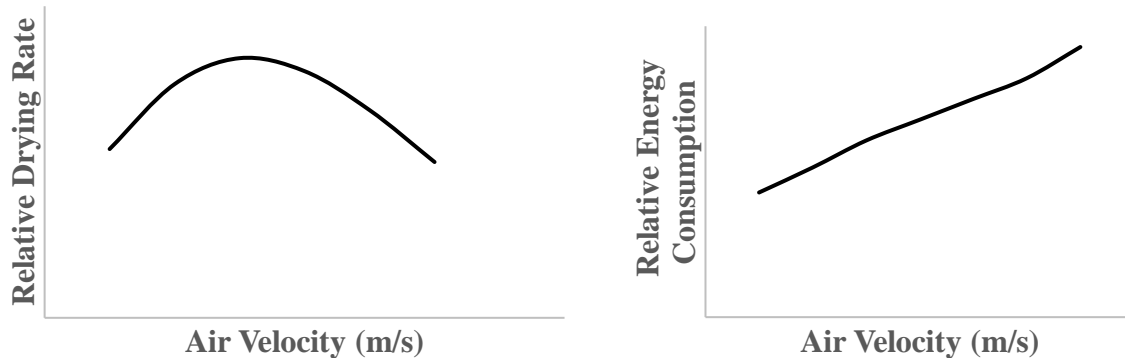


Figure 4: Conceptual influence of air velocity (m/s) on drying rate and energy consumption in hot air-drying system based on trends observed in the literature.

Table 3: Effect of drying air velocity on drying rate and energy consumption in hot air-drying system.

Author (Year)	Product	Velocity range	Effect on drying rate	Effect on energy consumption
Rajkumar et al. (2017)	Tomato slices	2-4 m/s	Optimum drying observed at 3 m/s; lower (2 m/s) reduced moisture removal, while higher (4 m/s) decreased drying efficiency due to insufficient air heating	Excessive velocity reduced moisture pickup
Moussa Na Abou et al. (2019)	Tomato slices	2-3 m/s	Increase in air velocity enhanced drying rate; effective moisture diffusivity increased by ~ 25%	Higher airflow increased fan energy demand
Nurkhoeriyati et al. (2021)	Celeriac slices	1.5-2.9 m/s	Higher air velocity significantly reduced drying time and enhanced mass transfer	Specific energy consumption increased due to higher airflow (fan power contribution)
EL-Mesery (2022)	Tomato slices	1-2 m/s	Increasing air velocity reduced drying period (up to ~ 24–25%)	Higher air velocity increased SEC and reduced thermal efficiency; lowest energy consumption observed at lower velocity (1 m/s)

### 3.4 Effect of slice thickness

Slice thickness is a critical geometric parameter in hot air-drying system which directly governs the moisture diffusion path length, surface-to-volume ratio, drying time and energy consumption. Reducing slice thickness generally accelerates

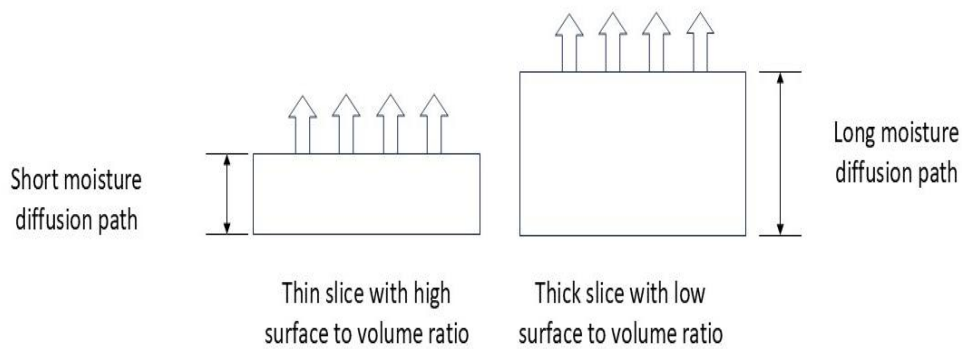
drying by shortening the internal moisture migration distance and increasing exposed surface area.

Hussein et al. (2016) [6] reported that 4 mm tomato slices dried faster than 6 and 8 mm slices because reducing the thickness decreases the diffusion path for moisture movement. They also showed that decreasing slice thickness improves

drying efficiency because lower thickness requires a lesser amount of energy due to the shorter drying time. Lin et al. (2023) [9] also similarly reported that increasing mango slice thickness from 3 mm to 10 mm reduced drying rate because of a longer moisture diffusion path, which consequently led to higher energy utilization per unit volume during the process. Similarly, Yazici and Kose (2024) [29] carried out experiments with tomato slices and found that thinner slices of 7 mm dried faster than 15 mm and quarter-size slices. As slice thickness increased, the dryer needed to operate for a longer time, which increased the power consumption of the process. For vegetables, Walke et al. (2025) [27] verified that reducing red onion slice thickness from 4 mm to 2 mm decreased drying time by 30.18% and improved thermal efficiency from 19.50%

to 27.89%, whereas thicker slices retained a moist core, which is unsuitable for powder production.

The conceptual illustration of the influence of the slice thickness on the drying rate and energy consumption is shown in below Fig. 5. The above reviewed studies indicate that thinner slices of fruits and vegetables dry faster and require lower energy consumption. In contrast, increasing thickness of slice increases the moisture diffusion path within the product, which results in longer drying time. Consequently, thicker slices require higher amount of energy for moisture removal during the process. Reducing slice thickness accelerates drying by shortening the internal moisture diffusion path and increasing the surface-to-volume ratio.



**Figure 5:** Conceptual illustration of the influence of slice thickness in hot air-drying system.

**Table 4:** Effect of slice thickness on drying rate and energy consumption in hot air-drying system.

Author (Year)	Product	Thickness range	Effect on drying rate	Effect on energy consumption
Hussein et al. (2016)	Tomato slices	4-8 mm	Drying time increased with thickness (4 mm: 300 min, 8 mm: 420 min); thinner slices dried faster	Hybrid drying of thinner slices reduced processing time and improved overall energy efficiency
Lin et al. (2023)	Mango slices	3-10 mm	Thinner slices (3 mm) showed faster drying due to higher surface area and shorter moisture diffusion path	Energy consumption per unit volume reduced; optimal balance observed at ~ 7 mm thickness
Yazici & Kose (2024)	Tomato slices	7-15 mm	Thinner slices reached target moisture faster; drying time increased significantly with thickness	Thicker slices resulted in higher specific energy consumption due to longer drying duration
Walke et al. (2025)	Red onion	2-4 mm	Drying time reduced by ~ 30% when thickness decreased from 4 mm to 2 mm	Thermal efficiency increased from 19.50% to 27.89% at lower thickness (2 mm)

### 3.5 Effect of tray porosity

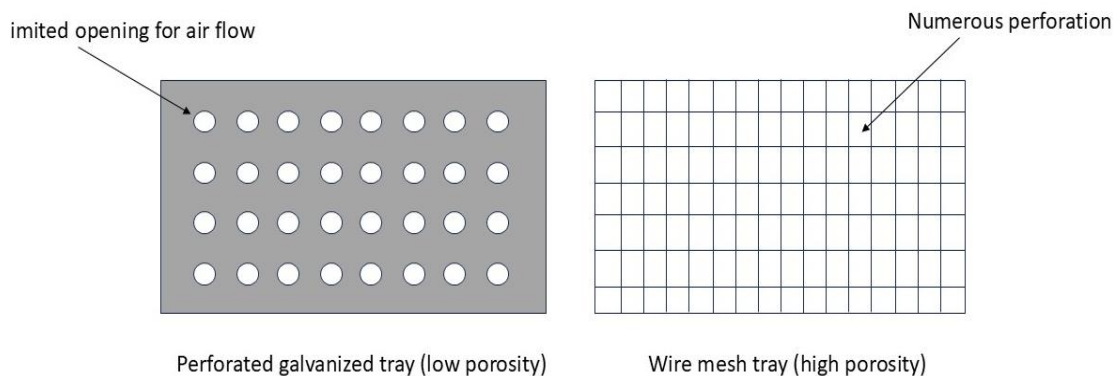
Porosity of the tray plays a key role in governing airflow distribution and overall drying performance in hot air-drying system. Tray with lower porosity can act as flow barriers, leading to non-uniform drying and extended drying time, whereas enhanced tray configurations improve air-product contact area and moisture removal efficiency.

Salhi et al. (2022) [22] investigated through CFD modelling and experiments that tray porosity is very important for airflow patterns within the drying chamber. Low tray porosity acts as a barrier to airflow, while increasing the porosity improves air penetration and increases the air temperature. Extending this work, Salhi et al. (2024) [23] experimentally compared wire mesh trays and perforated galvanized sheet trays for banana drying. They reported that A-type wire mesh trays significantly enhanced the drying rate,

reducing the moisture content from 69.2% to 19.4% within 7 hours compared to low-porosity galvanized sheet trays. In contrast, the galvanized trays also caused sticking of the drying product to the tray surface.

Similarly, Oria (2025) [15] also reported that the mesh wire improved airflow around the coffee beans. As a result, the desired moisture content of 12% was reached in 27 h with mesh wire, compared with 38 h without mesh wire and 47 h in open sun drying, indicating a faster drying process.

The reviewed studies indicate that low tray porosity results in poor airflow distribution, leading to longer drying time and reduced drying efficiency. In contrast, increasing tray porosity improves airflow distribution within the drying chamber, resulting in faster drying and enhanced drying efficiency as shown in below Fig. 6.



**Figure 6:** Conceptual illustration of the influence of tray porosity on airflow distribution in hot air-drying system.

**Table 5:** Effect of tray porosity on drying rate and energy consumption in hot air-drying system.

Author (Year)	Product	Tray type / configuration	Effect on drying rate	Energy implications
Salhi et al. (2022)	Plum	Constant porosity (30-70%); non-uniform porosity	30% porosity blocked airflow; 50% gave highest tray temperature; non-uniform porosity improved uniform drying	Tray porosity directly influenced pressure drop and airflow resistance, affecting overall drying efficiency
Salhi et al. (2024)	Banana slices	Wire mesh (Type A & B) vs. perforated galvanized sheet	Type A mesh trays showed fastest moisture reduction due to better airflow and heat transfer	Improved drying rate enhanced system efficiency and product quality; mesh trays reduced resistance to airflow
Oria (2025)	Coffee	Elevated wire mesh vs. PVC floor	Mesh wire significantly reduced drying time by improving airflow and enabling double-pass heating	Reduced drying time increased economic returns with negligible added cost

### 3.6 Effect of exhaust air recirculation

Recirculation of the exhaust air has the potential to improve the energy efficiency of hot air-drying system by recovering sensible and latent heat from exhaust air. By mixing a controlled portion of moist exhaust air with fresh inlet air, the drying temperature can be maintained with lower external energy input. But excessive recirculation increases air humidity inside the drying chamber which in turn reduces the mass transfer driving force, thereby extending total time of drying.

Samimi Akhijahani et al. (2023) [1] investigated the effect of exhaust air recirculation in a solar powered drying system. The study reported that higher air recirculation enhanced the

drying rate of rhubarb slices. They further reported that recirculation of exhaust air decreased the energy requirement for drying, which in turn reduced the specific energy consumption. Suherman et al. [24] evaluated the impact of exhaust air recirculation within a solar-powered configuration. They found that reutilization of exhaust air increased drying efficiency and decreased overall energy demand. However, at higher recirculation ratios, excessive moisture buildup inside the drying chamber reduced the drying rate.

This reviewed study suggests that there are optimal recirculation ratios around 40 - 60%, where energy recovery is maximized without excessive humidity buildup.

**Table 6:** Effect of air recirculation on drying rate and energy consumption in hot air-drying system

Author (Year)	Product	Recirculation (%)	Effect on drying rate	Effect on energy consumption
Samimi Akhijahani et al. (2023)	Rhubarb slices	0, 25, 50, 70%	Drying time reduced up to 50%; increased at 70% due to high humidity	Specific energy consumption reduced by at least 1.91%; efficiency increased by 2.32-8.21%
Suherman et al. (2025)	Coffee beans	0, 50, 100%	50% recirculation provided optimal drying rate	Lowest specific energy consumption of 3.887 kWh/kg at 100%

### 4. Future scope

Despite the extensive literature exists regarding the dehydration kinetics of agricultural produce, but most studies still focus on specific products and a limited number of operating parameters. As a result, universally applicable guidelines for drying different fruits and vegetables are still limited. Therefore, future research should investigate a wider range of agricultural and horticultural products under broader operating conditions in order to develop more generalized drying strategies. In addition, future studies should examine the combined effects of key environmental and operational variables on the dehydration of agricultural produce. Developing mathematical models that combine these

parameters is important for predicting drying behaviour and improving hot air-drying system operation.

### 5. Conclusions

This review highlights that dehydration of agricultural produce is influenced by both environmental and operational parameters. Ambient moisture level affects the processing speed by determining the moisture-holding capacity of air, whereas ambient temperature mainly influences the energy demand of the process. Among the controllable parameters, drying air temperature and air velocity strongly influence drying rate and energy consumption, with typical optimal ranges of 50-70 °C and 2-3 m/s, respectively. Slice thickness

governs diffusion path, where thinner configurations promote accelerated moisture loss due to shorter diffusion path, while thicker slices take longer drying time and use more energy. Tray design also plays an important role. Porous wire mesh trays improve airflow distribution compared to low-porosity galvanized trays. Recirculation of exhaust air can further enhance energy efficiency by recovering heat from the exhaust air but excessive recirculation increases humidity within the chamber and weakens the dehydration rate. Overall, these findings are useful for improving the design and operation of energy-efficient hot air-drying systems for various fruits and vegetables.

### Authors' contributions

The authors read and approved the final manuscript.

### Conflicts of interest

The authors declares no conflict of interest.

### Funding

This research received no external funding.

### Data availability

All relevant data and supporting information are included in the article, thus there is no need to consult external sources for more information.

### References

- [1] H.S. Akhijahani, P. Salami, M. Iranmanesh, M.S.B. Jahromi, Experimental study on the solar drying of rhubarb (*Rheum ribes* L.) with parabolic trough collector assisted with air recycling system, nanofluid and energy storage system, *J. Energy Storage* **60** (2023) 106451.
- [2] F. Akter, R. Muhury, A. Sultana, U.K. Deb, A comprehensive review of mathematical modeling for drying processes of fruits and vegetables, *Int. J. Food Sci.* **2022** (2022) 6195257.
- [3] H. Davidsson, J. Olsson, R. Phinney, R. Bernardo, P. Otte, L.D. Tivana, Towards a homogenous drying rate using a solar fruit dryer, Proc. ISES Solar World Congress 2017 / SHC 2017 Conf. (2017).
- [4] H.S. El-Mesery, Improving the thermal efficiency and energy consumption of convective dryer using various energy sources for tomato drying, *Alex. Eng. J.* **61** (2022) 10245–10261.
- [5] Y.S. Hamed, H.E. Embaby, K.M. Youssef, E. Fayad, O.A. Abu Ali, F. Althobaiti, S.K. El-Samahy, A.A. Gaballah, Impact of drying temperature and slice thickness on the drying kinetics, color properties, and antioxidant activity of the Egyptian *Opuntia dillenii* fruit, *Ital. J. Food Sci.* **37** (2025) 416–426.
- [6] J.B. Hussein, K.B. Filli, M.O. Oke, Thin layer modelling of hybrid, solar and open sun drying of tomato slices, *Res. J. Food Sci. Nutr.* **1** (2016) 15–27.
- [7] Ö.G. Kocabay, O. İsmail, İ. Doymaz, Effect of hot air drying temperature on drying kinetics, physico-chemical properties, and energy consumption of culture asparagus (*Asparagus officinalis* L.), *Period. Polytech. Chem. Eng.* (2024).
- [8] P.K. Kumar, K. Ramakrishna, S.A. Vemuri, S. Koneru, B. Challa, A. Singla, N. Duklan, H. Alabdeli, Identifying the impact of key parameters on the drying kinetics of onion (*Allium cepa* L.) slices, *Cogent Eng.* **12** (2025) 2528090.
- [9] Q. Lin, X. Zong, H. Lin, X. Huang, J. Wang, S. Nie, Based on quality, energy consumption selecting optimal drying methods of mango slices and kinetics modelling, *Food Chem. X* **17** (2023) 100600.
- [10] Ministry of Food Processing Industries, Food processing: Towards sustainable growth opportunities - Sector profile: Fruits and vegetables, Government of India (2024).
- [11] M. Moussa Na Abou, S. Madougou, M. Boukar, Effect of drying air velocity on drying kinetics of tomato slices in a forced-convective solar tunnel dryer, *J. Sustain. Bioenergy Syst.* **9** (2019) 64–78.
- [12] K. Noopur, J.K. Chauhan, L. Kumar, A.K. Chandegara, S.S. Panwar, Vegetables for food and nutritional security: A review, *Indian Res. J. Ext. Educ.* **23** (2023) 21–27.
- [13] A.W. Noori, M.J. Royen, J. Haydari, Effect of ambient parameters change on mint leaves solar drying, *Acta Chim. Slovaca* **14** (2021) 14–24.
- [14] T. Nurkhoeriyati, B. Kulig, B. Sturm, O. Hensel, The effect of pre-drying treatment and drying conditions on quality and energy consumption of hot air-dried celeriac slices: Optimisation, *Foods* **10** (2021) 1758.
- [15] C.L. Oria, Drying performance of integrating mesh wire as drying space into the inflatable solar dryer for drying coffee, *Eng. Technol. J.* **10** (2025) 3846–3850.
- [16] R.A. Olmos-Cruz, G. Martínez-Rodríguez, E. Sánchez-García, Drying kinetics in solar dehydration of tomato, *J. Sustain. Dev. Energy Water Environ. Syst.* **13** (2025) 1130611.
- [17] Press Information Bureau, Government of India, Horticulture: Strengthening India's agri-economy — Focusing on high-value crops to boost farmer incomes, (2025).
- [18] S.P. Rajkumar, A.P. Venugopal, A. Viswanath, N. Varadharaju, Effect of air velocity and pre treatment on drying characteristics of tomato slices during solar tunnel drying, *Int. J. Curr. Microbiol. Appl. Sci.* **6** (2017) 573–580.
- [19] J. Ranjan, R. Sahni, Post-harvest losses of fruits and vegetables in India, Ropan 11 (2023) CHH-BIL/2020/79641.
- [20] G. Ruzikulov, U. Ibragimov, T. Faiziev, S. Mirzayorova, A. Ruzikulov, Study of the temperature and humidity regime in solar drying of agricultural products, *BIO Web Conf.* **71** (2023) 01042.
- [21] V.R. Sagar, P.S. Kumar, Recent advances in drying and dehydration of fruits and vegetables: A review, *J. Food Sci. Technol.* **47** (2010) 15–26.
- [22] M. Salhi, D. Chaatouf, B. Raillani, S. Amraqui, A. Mezrhah, Investigating the effect of food trays porosity on the drying process, *Innov. Food Sci. Emerg. Technol.* **76** (2022) 102939.
- [23] M. Salhi, D. Chaatouf, B. Raillani, S. Amraqui, A. Mezrhah, Experimental investigation and performance evaluation of an indirect solar dryer: Effect of drying trays, *Sol. Energy* **272** (2024) 112482.
- [24] S. Suherman, D.D. Anggoro, S. Sugiharto, M.A. Asy-Syaqiq, Investigation of a mixed-mode solar dryer assisted with an air recycling system and phase change material unit for coffee beans drying: An experimental study, *Renew. Energy* **254** (2025) 123762.
- [25] S. Tan, Y. Miao, C. Zhou, Y. Luo, Z. Lin, R. Xie, W. Li, Effects of hot air drying on drying kinetics and anthocyanin degradation of blood-flesh peach, *Foods* **11** (2022) 1596.
- [26] A. Thakur, R. Sharma, D. Vaidya, N. Sharma, D. Thakur, R. Suhag, Effect of slice thickness and pretreatments on the quality of dried apple slices (Golden Delicious), *J. Food Biochem.* **2024** (2024) 1711150.
- [27] S. Walke, M. Mandake, M. Naniwadekar, R. Tapre, Dehydration of onion slices for food processing application using Internet of Things-based smart solar drying system, *J. Sol. Energy Eng.* **147** (2025) 014501.
- [28] H.S. Waskale, S.B. Bhote, M.G. Bhong, Effect of air recirculation in the energy saving during drying process of fruits, vegetables and grains: A review, *Int. J. Theor. Appl. Res. Mech. Eng.* **6** (2017) 154–156.
- [29] M. Yazici, R. Kose, Energy, exergy and economic investigation of novel hybrid dryer, indirect solar dryer and traditional shade drying, *Therm. Sci. Eng. Prog.* **49** (2024) 102502.