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RESEARCH PAPER

Drying characteristics optimization of blanched day lily buds using a heat pump dryer

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Key Message: This study indicates drying day lily buds with 6 minutes of blanching, 60 ℃ blanching temperature, and 40 ℃ drying air temperature using a heat pump promotes high-quality dried day lily buds in terms of high vitamins, long shelf life, and better nutritional value. Lower drying temperature under a heat pump leads to less drying energy used for the process.

Abstract

Blanching significantly enhances the improvedrying conditions of day lily buds, yet there is limited information on optimal drying kinetics using heat pump dryers. This research aimed to optimize the drying characteristics of day lily buds by examining the drying rate and rehydration ratio. The heat pump drying air temperatures were set at 40 °C, 50 °C, and 60 °C, while blanching was conducted for 2, 4, and 6 minutes at the same temperatures. The average drying air velocity was maintained at 2.2 m/s, and relative humidity was controlled. Using the $L_9(3^3)$ Taguchi experimental design, the study identified the best combinations of parameters that maximized drying rate and rehydration ratio. Results indicated that increasing the blanching time from 2 to 6 minutes increased the drying rate of day lily buds from 1.098 kg/kg/min to 1.744 kg/kg/min. Similarly, increasing blanching temperature from 40 °C to 60 °C raised the drying rate from 1.382 to 1.468 kg/kg.min. Conversely, raising the air temperature from 40 °C to 60 °C resulted in a decreased drying rate from 1.491 kg/kg.min to 1.403 kg/kg.min. Rehydration ratios improved correspondingly, rising from 1.344 to 2.349 with the higher blanching time of 6 minutes. Also, an increase in blanching temperature enhanced the rehydration ratio from 1.835 to 1.976. Blanching time had more influence on both drying rate and the rehydration ratio of day lily buds, followed by blanching temperature and drying temperature, respectively. Ultimately, the optimal conditions for drying day lilies, 6 minutes of blanching at 60 °C with drying air temperature of 40 °C, promote high-quality, nutritious, and safe dried day lilies, preserving vitamins and increasing shelf life. Drying air temperature of 40 °C also ensures energy efficiency through lower drying temperatures as compared to 50 °C and 60 °C.

Keywords: Blanching conditions, Day lily, Drying kinetics, Heat pump dryer, Optimization, Rehydration

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Introduction

Day lily buds (*Hemerocallis spp.)* are tuft-forming, perennial monocotyledonous crops belonging to the *Liliaceae* family. The plant comprises fibrous tubers, a crown, leaves, and flowers. Day lilies are grown worldwide, with Asian countries leading (Jianxin et al., 2005; Liu & Liao, 2025). The plant's buds are comestible and nutritious, while the tubers are known to possess pain-relieving properties, hence making it extensively used as vegetables, ointments for fevers, breast tumors, hemorrhoids, and jaundice (Yanjun et al., 2004; Fei et al., 2017; Szewczyk et al., 2020). Day lily flower extracts impede cell proliferation, persuade cancerous cells to undergo cell differentiation, and exhibit strong antioxidant activity due to high content of bioactive components (Shenghua et al., 2012; Ying, 2013). Day lilies have also been used to treat insomnia, inflammation, and depression (Katarzyna et al., 2019; Liu & Liao, 2025). These wealthy usefulness of day lilies has made it a more admirable solution to the health and food security sectors. This has further attracted wide acceptance for food and medicinal use in Asia, Europe, and America, among other countries. However, like most vegetables, day lilies are harvested at high moisture content (above 85%) and in huge amounts during the flourishing season. High moisture content causes a high rate of decay and complicates transportation due to the bulkiness associated with the high moisture content. Drying is one of the alternative solutions to these technical hitches since the moisture content is reduced to a chemically stable condition for the product (Akter et al., 2024; Motegaonkar et al., 2024; Liu et al., 2025). Drying reduces crop losses; simplifies value addition; eases transportation; betters product handling; extends shelf-life; and is economical as compared to other preservation techniques (Ertekin & Firat, 2017; Kırbaş et al., 2019).

Natural and hot air-drying are some of the methods that have been used to preserve edible flowers like day lilies.

Natural drying encompasses sun drying, air drying, and shade drying, and is characterized by using simple techniques and cheaper equipment. However, natural drying is unreliable due to unpredictable weather changes and longer uncontrolled drying time that easily contaminates the flowers by predisposing them to dust, impurities, pests, and other forms of pollution (Choudhary & Gopirajah, 2018; Linlin et al., 2019; El-Kolaly et al., 2025). On the other hand, hot air drying hastens drying processes of most agro-products, averts crop losses, easy control of drying parameters, hence production of quality products (Bansode et al., 2025). Despite the aforementioned strengths, drying products at high temperatures for a long time can damage nutrients and the physical appearance of food (Linlin et al., 2019). These characteristics are undesirable to consumers who prefer minimal quality variations (Elwakeel et al., 2025). Again, different drying methods with different temperatures, such as vacuum freeze drying, hot air drying, vacuum drying, and infrared drying, have been used to dry day lilies. Treatments like temperature used for the process ranged from -80 °C in freeze drying to 65 °C. The investigated quality parameters included amino acid analysis, total phenolic content, colour, flavonoid content, polysaccharides, and alkanoids (Xie et al., 2024). The findings recommended that vacuum freeze drying has higher potentiality of conserving bioactive constituents in lily bulbs. Despite the suggested vacuum freeze drying having better preservative qualities, its use is limited due to the high energy demand to attain the negative temperature and for a longer time. This leaves Heat pump drying as the alternative due to low energy demand and drying treatment flexibilities.

Heat pump drying is one of the best ways of improving the drying kinetics of day lilies. The dryers have high energy efficiency due to energy recovery and easy control of drying parameters, thus widely used to dry many agricultural products (Greco et al., 2024; Zhang et al., 2024). As a result of the aforementioned advantages, heat pumps have been widely used to dry many agricultural products (Aktaş et al., 2009; Minea, 2013; Fayose & Huan, 2016). However, little information exists on optimised drying kinetics of day lily buds using heat pumps. For day lily, this implies preserving colour, nutritional content, and the value of antioxidants. It is suggested that pre-treatment before drying helps to reduce colour changes, textural changes, and increases drying rate by soothing tissue structure in addition to enhanced quality (Daud et al., 2024). For instance, blanching helps to destroy microbes in the product, quickens drying rate, softens product texture, and makes fine cracks on the drying product (Hong et al., 2014; Galoburda et al., 2015). Response parameters like rehydration ratio help to predict the level of damage caused by physical and chemical processes in a drying operation. For example, a high rehydration ratio infers less cellular devastation and dislodgment (Xing et al., 2025). However, despite the usefulness of blanching and heat pump drying in many fruits and vegetable drying, little documented literature exists regarding optimized parameters that can give a high drying rate and rehydration ratio of day lily buds. Consequently, the current study focuses on drying characteristics of day lily buds using a heat pump dryer and optimizing the drying process of day lily buds to get a high drying rate and rehydration ratio of day lily buds under a heat pump dryer.

Materials and Methods

Sample preparation and experimentation

Clean day lily buds were bought from Sugou market in Pukou District of Nanjing City, China, and transported in well-insulated boxes with ice balls enclosed inside to maintain cool temperatures. They were weighed into 500 grams for each experiment. The weighed day lily buds were then blanched at temperatures of 40 °C, 50 °C, and 60 °C. Blanching time was done at 2, 4, and 6 minutes appropriately for each trial. Blanched buds were placed in meshed trays for drying using a laboratory heat pump at department of Agricultural Mechanization, Pukou campus, Nanjing Agricultural University, China. The heat pump dryer was run for 30 minutes to stabilize the constant drying air temperature before experimentation. Drying air temperatures were controlled at 40 °C, 50 °C, and 60 °C in particular experiments using a Programmable Logic Controller (PLC) device attached to the heat pump system for data recording and controlling operational parameters. Drying air velocity measured using a digital airflow anemometer (Shenzhen Jumaoyuan Science and Technology Co, Ltd) was averagely 2.2 m/s, while relative humidity was treated superfluously during experimentation. $L_9(3^3)$ Taguchi design experiment with three replicates was used (Table 1). The heat pump dryer system used for drying the day lily buds consisted of the heating system and the drying chamber (Fig. 1).

Drying rate determination

Moisture content for fresh and dried day lily buds was determined using the oven drying method according to American Society of Agricultural Engineers (ASAE) standards S352.2 at 102 °C for 24 hours. Sample weights were taken and recorded at intervals of 60 minutes till insignificant mass change was noted using a precision weighing balance (Jsc-600 electronic balance, Kaifeng Group Co. Ltd). Wet basis moisture content (M_{wb}) was determined using Equation 1 and converted to instantaneous dry basis moisture content (M_t) using Equation 2. Drying rates were calculated using Equation 3. Variation of drying rate (g/g.min) with change in blanching time, blanching temperature, and drying air temperature was appropriately investigated for optimization purposes.

$$m_{wb} = 100 - \frac{W_w(100-M_0)}{W_t} \quad (1)$$

$$m = \frac{M_{wb}}{1-M_{wb}} \quad (2)$$

$$dr = \left[\frac{m_i - m_{i+1}}{\Delta t}\right] \quad (3)$$

where dr, m, m_i, m_{i+1} and Δt are drying rate, moisture content, previous moisture content (dry basis), subsequent moisture content (dry basis), and change in time with i= 0,1,2,3..., respectively.

Table 1 L_9 Taguchi design experiment for drying characteristics of day lily buds

Experiment number	Blanching time (minutes)	Blanching temperature (°C)	Drying air temperature (°C)
1.	2	40	40
2.	2	50	50
3.	2	60	60
4.	4	40	50
5.	4	50	60
6.	4	60	40
7.	6	40	60
8.	6	50	40
9.	6	60	50

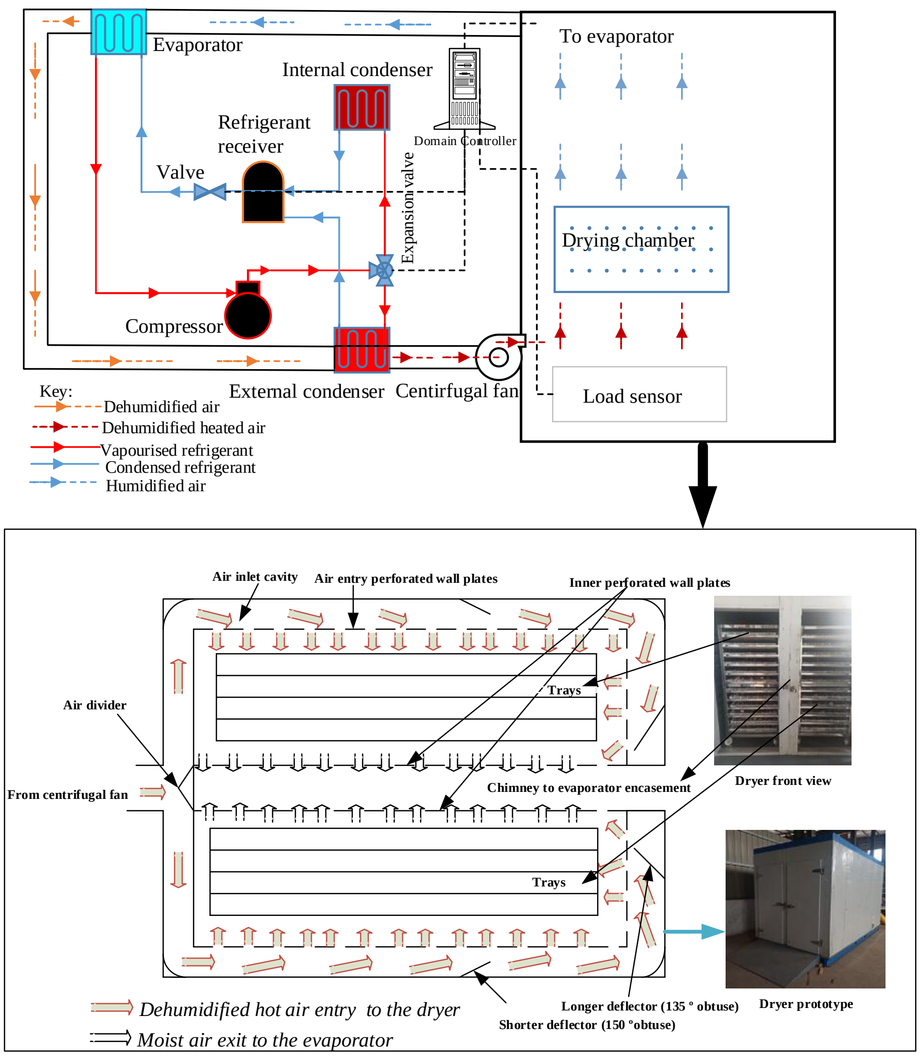

Fig. 1 Heat pump dryer system

Determination of rehydration ratio for day lily buds

Rehydration ratio shows the level of damage caused by physical and chemical processes occurring during drying of the products (Arulkumar et al., 2024; Salehi et al., 2024; Özkan et al., 2025). 20 grams of dried day lily buds were dipped in water at a controlled temperature of 40 °C using a thermostatic electric kettle. They were then removed and carefully dried off using tissue paper and reweighed. Equation 4 was used to determine the rehydration ratio of dried products at varying blanching times, blanching temperatures, and drying air temperatures:

$$R_h = \frac{w_r}{w_d} \quad (4)$$

Where R_h is the rehydration ratio, w_r is the weight of rehydrated day lily buds, w_d is the weight of dried day lily buds.

Taguchi optimization of the drying process

The Taguchi technique is a powerful tool for the design of high-quality systems and processes due to its efficiency, simplicity, quality, and cheapness (Mitra et al., 2015). $L_9(3^3)$ array was used for experimentation. Experiments were done in triplicate, and their mean values were recorded for Taguchi analysis to get parameter influences on drying rate and rehydration ratio. Additionally, the Taguchi method was used to find the optimum combination of blanching time, blanching temperature, and drying air temperature that gave maximum drying rate and rehydration ratio. This was attained using Equation 5, as it is majorly used when the larger the better objective is desired (Athreya & Venkatesh, 2012):

$$S/N = -10\log\frac{1}{n}\left(\sum\frac{1}{y^2}\right) \quad (5)$$

Where n is the total number of samples, and y is the individual sample observations.

Data analysis

Experimentation for day lily buds was done in triplicate. The Taguchi design of experiment method was used for data analysis. The influence of blanching time, blanching temperature, and drying air temperature on drying rate and rehydration ratio was analyzed and presented. In determining if there was a significant difference in means, Least Significant Difference (LSD) at 5% significance level for the effects of blanching time, blanching temperature, drying air temperature, drying rate, and rehydration ratio was performed. Statistical analyses were performed using Minitab-22.4.0 (Minitab Inc., USA).

Results and Discussion

Interactions of selected parameters on day lily buds' drying rate

The values of the drying rate for day lily buds were calculated using Equation 3. The influence of varying blanching time and blanching temperature on the drying rate of day lily buds under a heat pump dryer is shown in Table 2. The data evidently revealed that increasing blanching time from 2 minutes to 6 minutes increased the drying rates of buds from 1.098 kg/kg.min to 1.744 kg/kg.min while increasing blanching temperature from 40 °C to 60 °C increased drying rates from 1.382 kg/kg.min to 1.468 kg/kg.min with no change in the least significant difference (LSD). The results imply that increasing the blanching time of day lily buds increases respective drying rates, as can be observed at the blanching time of 6 minutes (Table 2). These observations were attributed to the fact that at lower blanching time, the intermolecular structural pores had not opened enough to allow quick moisture transfer, hence leading to a low drying rate. Drying rate was maximum at 6 minutes' blanching time, implying that high blanching time increased drying rate by opening intercellular pores, hence hastening drying processes in the buds. Correspondingly, raising the blanching temperature from 40 °C to 60 °C increased the drying rates from 1.382 kg/kg.min to 1.468 kg/kg.min. When the blanching temperature is higher, raised heat transfer processes could increase water activity (a_w), causing a high drying rate of day lily buds. On the other hand, increasing drying air temperature decreased the drying rate of day lily buds from 1.491 kg/kg.min at 40 °C to 1.403 kg/kg.min at 60 °C.

The ability of blanching to increase drying rate was due to the fact that blanching takes away air from the tissues, thus increased perviousness of the tissue (Jun et al., 2017). Similar observations have been reported by Mahari and Mohamed (2025) in the drying kinetics of onion slices using a cabinet dryer. Additionally, a rise in drying rate with a rise in blanching time was associated with high blanching time, which caused more intermolecular structural pores' opening, hence causing a high drying rate. Other works in literature that portrayed similar observations included drying of potato slices (Pathan et al., 2025), persimmon fruit slices (Doymaz, 2012), and drying unripe banana slices (Martínez et al., 2024). However, use of high blanching temperatures for a long time causes breaking of membranes, plasmalemma, and cell-wall, leading to lower drying rate (Taiwo & Adeyemi, 2009; Martínez et al., 2024; Wu et al., 2025). Fisher's Least Significant Difference (LSD) results clearly showed that varying blanching time significantly influenced the drying rate of day lily buds (p>0.05).

Another phenomenon that causes an increased drying rate with a rise in blanching temperature is the formation of micro-cracks. Increased micro-cracks increase the surface area over which evaporation occurs, hence the raised drying rates of day lily buds. It has been found that increasing micro-cracks with blanching temperature raises drying rate (Hong et al., 2014). Similar observations have also been observed in the drying process of pepper (Jun et al., 2017) and banana slices (Ratiya et al., 2011), apple slices (Wu et al., 2025), and broccoli florets (Borucu & Doymaz, 2025). Fisher's (LSD) results clearly showed that varying blanching temperature significantly influenced the drying rate of day lily buds (p>0.05). This was due to structural changes that occur, especially at high temperatures. A decrease in drying rate at 60 °C was more prevalent at a high blanching time of 6 minutes. The observation was caused by textural changes as a result of a long blanching time that softened the buds. Over-softening of the texture can collapse the normal structure of day lily buds, hence impeding diffusivity. Other works in literature have also observed similar behaviour in many crops that are blanched before drying (Jun et al., 2017; Dawei & Chen, 2018; Borucu & Doymaz, 2025; Wu et al., 2025). Variation of drying air temperature had an insignificant influence on drying rate (p<0.05).

Table 2 Variation of selected parameters on the day lily bud's drying rate

Parameter	Level	Drying rate (kg/kg.min)
Blanching time	2 minutes	1.098[a]
	4 minutes	1.449[b]
	6 minutes	1.744[c]
	LSD	0.053
Blanching temperature	40 °C	1.382[a]
	50 °C	1.441[b]
	60 °C	1.468[b]
	LSD	0.053
Drying air temperature	40 °C	1.491[a]
	50 °C	1.397[b]
	60 °C	1.403[b]
	LSD	0.053

Means that do not share a letter are significantly different.

Influences of selected parameters on the rehydration ratio of day lily buds

Table 3 shows the influences of varying blanching time, blanching temperature, and drying air temperature on rehydration ratio. Rehydration ratio increased from 1.344 to 2.3493 as time increased from 2 minutes to 6 minutes. This demonstrated that increasing blanching time gives more time to expel air from the day lily buds tissues, hence increasing permeability. Similarly, the rehydration ratio rose from 1.835 to 1.976 as the blanching temperature rose from 40 °C to 60 °C, respectively. Variation of blanching time had a significant influence on rehydration ratio (p<0.05) while variation of blanching temperature had an insignificant influence on rehydration ratio (p>0.05). On the other hand, the rehydration ratio dropped from 1.944 to 1.870 with a rise in drying air temperature from 40 °C to 60 °C. This demonstrated that raising drying air temperature negatively affected the rehydration ratio of dried day lily buds.

Rehydration ratios are used to assess quality for dried products by analyzing the physical-chemical fluctuations caused by drying effects on the food product. Further, rehydration is the degree to which dried agricultural produce recovers the original fresh state upon rehydration and assists as an indicator of structural changes in the dried material (Dandan et al., 2014; Yang et al., 2025). Based on this argument, increasing blanching time, blanching temperature, and decreasing drying air temperature, as observed from Table 3, improve the rehydration ratio of dried day lily buds.

From the observation made in Table 3, increasing blanching temperature led to more intercellular openings, leading to the high rehydration ratio. Consequently, the rehydration ratio increased with a rise in blanching temperature, as also observed by Sukhcharn et al. (2006). For that reason, blanching temperature improves rehydration ratio because of the effect of high temperature on cell walls and tissue structure of day lily buds using a heat pump dryer. A similar trend has been observed in rehydration kinetics and colour of sweet potato slices (Sukhcharn et al., 2006), drying of shepherd's purse (Wu et al., 2025), pickled carrots (Madurangi & Marapana, 2025), and drying characteristics of leek slices (Ibrahim, 2008). The reduction in rehydration ratio with a rise in drying air temperature showed that high temperature easily caused surface hardening and other structural denaturing, making it impermeable for moisture to penetrate during the rehydration of day lily buds. Thus, drying day lilies that have been exposed to long-time blanching and high drying temperatures led to a poor rehydration ratio. Variation of air temperature had an insignificant influence on the rehydration ratio (p>0.05).

Table 3 Variation of rehydration ratio with blanching time and blanching temperature

Parameter	Level	Drying rate (kg/kg.min)
Blanching time	2 minutes	1.344[a]
	4 minutes	1.955[b]
	6 minutes	2.349[c]
	LSD	0.190
Blanching temperature	40 °C	1.835[a]
	50 °C	1.838[a]
	60 °C	1.976[a]
	LSD	0.190
Drying air temperature	40 °C	1.944[a]
	50 °C	1.834[a]
	60 °C	1.870[a]
	LSD	0.190

Means that do not share a letter are significantly different.

Optimization of day lily buds' drying characteristics

Fig. 2 shows signal-to-noise ratios for effects and interactions of chosen constraints on day lily buds' drying rate as generated from Minitab-22.4.0 (Minitab Inc., USA). With respect to high drying rate, a combination of 6 minutes of blanching time, 50 °C blanching temperature, and 40 °C drying air temperature was most preferred. Table 4 demonstrates the responses of selected parameters in influencing the drying rate of day lily buds. Blanching time ranked first in influencing the drying rate of day lily buds, followed by blanching temperature and drying air temperature, respectively. With regard to the high drying rate, a combination of 6 minutes of blanching time, 60 °C blanching temperature, and 40 °C drying air temperature was the best (Fig. 3).

Table 5 demonstrates the responses of the selected parameters in influencing the rehydration ratio of day lily buds.

It evidently demonstrates that blanching time had more influence on day lily buds' rehydration ratio, followed by blanching temperature and drying air temperature, respectively. More blanching time led to the disruption of the day lily bud's cells. This created more channels for water to penetrate the day lilies during the rehydration process. Additionally, the disruption of cells led to more pore formation, which resulted in increased porosity that permits faster water entry, resulting in a higher rehydration ratio.

Table 4 Responses for signal to noise ratios for drying rate

Level	Blanching time	Blanching temperature	Drying air temperature
1	0.064	1.202	1.983
2	1.571	1.981	1.449
3	3.147	1.600	1.350
Delta	3.083	0.779	0.633
Rank	1	2	3

Table 5 Responses for signal to noise ratios for rehydration ratio

Level	Blanching time	Blanching temperature	Drying air temperature
1	2.544	4.935	5.412
2	5.756	5.032	5.001
3	7.272	5.605	5.159
Delta	4.729	0.670	0.410
Rank	1	2	3

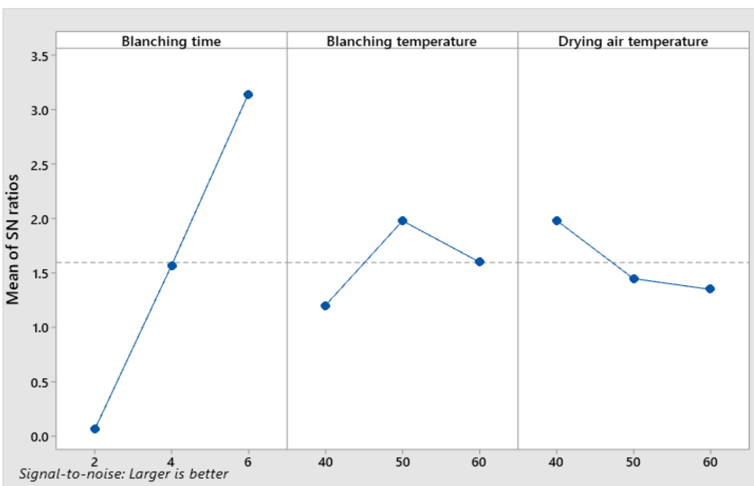

Fig. 2 Means of signal to noise ratio for drying rate of day lily buds

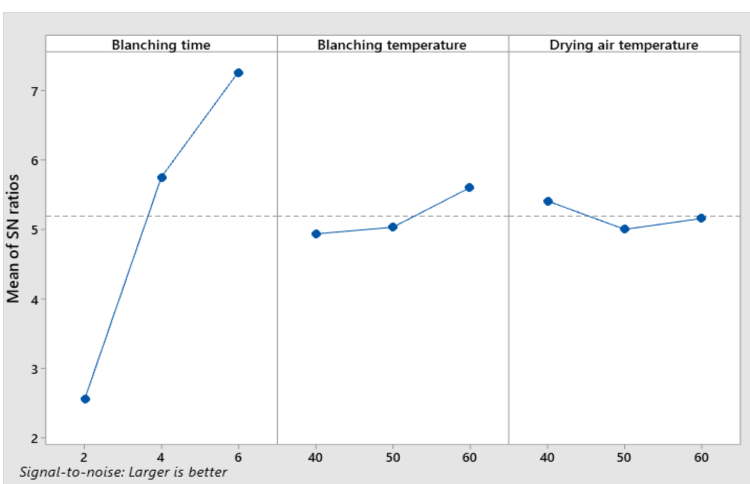

Fig. 3 Means of signal-to-noise ratio for the rehydration ratio of day lily buds

Conclusion

The current study is primarily concerned with optimizing the drying conditions of day lily buds with regard to high drying rate and rehydration ratio using a laboratory heat pump dryer. A heat pump dryer was chosen due to its ability to recover energy, thus saving drying costs. Like many other agricultural food materials, drying is among the vital preservation operations for the production of quality day lily buds. The current work aimed to have a combination of drying parameters that gave the highest drying rate and rehydration ratio. It was found that increasing blanching time from 2 minutes to 6 minutes caused a rise in drying rate from 1.098 kg/kg.min to 1.744 kg/kg.min. An upsurge in blanching temperature from 40 °C to 60 °C led to an increased drying rate from 1.382 kg/kg.min to 1.468 kg/kg.min. On the contrary, drying rate decreased from 1.491 kg/kg.min to 1.403 kg/kg.min as temperature rose from 40 °C to 60 °C. The parameters and their interactions significantly influenced the drying rate of day lily buds ($p<0.05$). Similarly, increasing blanching time raised rehydration from 1.344 to 2.349, while a rise in blanching temperature increased rehydration from 1.835 to 1.976. However, raising the air temperature from 40 °C to 60 °C led to a decrease in rehydration ratio from 1.944 to 1.870. Only the variation of blanching time had a significant influence on rehydration ratio ($p<0.05$). A combination of 6 minutes blanching time, 60 °C blanching temperature, and 40 °C drying air temperature resulted in the highest drying rate, while 6 minutes blanching time, 50°C blanching temperature, and 40 °C drying air temperature had the highest desired rehydration ratio. As high blanching temperature leads to destruction of microstructural cells, a 50 °C blanching temperature was optimal. Thus, the optimal combinations for both drying rate and rehydration ratio of the dried day lily buds under a heat pump dryer were 6 minutes of blanching time, 50 °C blanching temperature, and 40 °C drying air temperature.

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Data availability: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

i. Ethics approval and consent to participate: Ethical approval and informed consent were not required for this study as it did not involve human participants, human data, or animals. The data used in this study were experimentally collected and did not contain any identifiable personal information. The authors declare that this is their original work and that it has not been published elsewhere.

ii. Conflict of Interest: None

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References

Aktaş, M., Ceylan, İ., & Yilmaz, S. (2009). Determination of drying characteristics of apples in a heat pump and solar dryer. *Desalination, 239,* 266-275. https://doi.org/10.1016/j.desal.2008.03.023

Akter, J., Hassan, J., Rahman, M. M., Biswas, M. S., Khan, H. I., Rajib, M. M. R., Ahmed, M. R., Khan, M. N.-E.-A., & Hasan, M. F. A. (2024). Colour, nutritional composition, and antioxidant properties of dehydrated carrot (*Daucus carota* var. Sativus) using solar drying techniques and pretreatments. *Heliyon, 10*(2). e24165. https://doi.org/10.1016/j.heliyon.2024.e24165

Arulkumar, M., Karpoora, S. P., N, Murugan, B., Eyarkai, N. V., Sivaranjani, S., Yogeshwari, R., Baskaran, D., Ganga Kishore, S., & Pandiselvam, R. (2024). Investigation of the dehydration and rehydration behavior of osmotic pretreated paneer slices (indian cottage cheese) and its modeling approach. *Journal of Food Process Engineering, 47*(8), e14718.

Athreya, S., & Venkatesh, Y. (2012). Application of taguchi method for optimization of process parameters in improving the surface roughness of lathe facing operation. *International Refereed Journal of Engineering and Science, 1*(3), 13-19.

Bansode, V., Ganga, K. S., Rajkumar, R., Dwivedi, M., Pradhan, R. C., Nongmaithem, R., Jeevarathinam, G., & Jaganathan, D. (2025). Impact of plasma-activated water pretreatment and hot-air drying on bioactive compounds, drying kinetics, structural characteristics, and functional properties of debittered sweet orange peel powder. *Heat Transfer, 54*(7), 4239-4259. https://doi.org/10.1002/htj.70062

Borucu, E., & Doymaz, I. (2025). Investigation of drying kinetics, color, and rehydration parameters of broccoli florets dried with infrared radiation following blanching pretreatment. *Chemical Engineering Communications, 212*(4), 603-616.

Choudhary, A., & Gopirajah, R. (2018). Computational modeling of the dehydration of mushrooms. *MOJ Food*

Processing & Technology, 6(3), 264-270. https://doi.org/10.15406/mojfpt.2018.06.00174

Dandan, Z., Kejing, A., Shenghua, D., Lijun, L., Zhiqiang, X., & Zhengfu, W. (2014). Two-stage intermittent microwave coupled with hot-air drying of carrot slices: Drying kinetics and physical quality. *Food Bioprocess Technology, 7*, 2308–2318. https://doi.org/10.1007/s11947-014-1274-1

Daud, N. F. S., Said, F. M., Mohyiddin, I. M., Mohamad, S. F. S., Zin, N. H. M., Zakil, F. A., & Muhamad, S. S. (2024). Investigating the impact of blanching and salt treatment on the drying kinetics of oyster mushrooms. *Bioresource Technology Reports, 27*, 101943.

Dawei, Y., & Chen, G. (2018). Effect of blanching on the quality of dried daylily. *Hans, 7*(4), 274-279. https://doi.org/10.12677/hjfns.2018.74033

Doymaz, İ. (2012). Evaluation of some thin-layer drying models of persimmon slices (*Diospyros kaki* L.). *Energy Conversion Management, 56*, 199-205. https://doi.org/10.1016/j.enconman.2011.11.027

El-Kolaly, W., Abdelkader, T. K., Wang, Y., Abd-Elhalim, H., Li, M., Rong, J., & Abdelhamid, M. A. (2025). Mushroom drying optimization using the Taguchi and Composite desirability methods. *Journal of the Science of Food and Agriculture. 105*(12), 6746-6760. https://doi.org/10.1002/jsfa.14383

Elwakeel, A. E., Ali, G., Eldin, A. Z., Alsebiey, M. M., Tantawy, A. A., Al-Harbi, M. S., Ahmed, A. F., & Metwally, K. A. (2025). Influence of physical shape and salting on tomato drying performance using mixed-mode solar and open-air methods in semi-cloudy weather. *Scientific Reports, 15*(1), 26340.

Ertekin, C., & Firat, M. Z. (2017). A comprehensive review of thin-layer drying models used in agricultural products. *Food Science and Nutrition, 57*(4), 701-717. https://doi.org/10.1080/10408398.2014.910493

Fayose, F., & Huan, Z. (2016). Heat pump drying of fruits and vegetables: Principles and potentials for sub-saharan africa. *International Journal of Food Science, 2016*, *9673029*. http://dx.doi.org/10.1155/2016/9673029

Fei, Q., Linchun, M., & Xiaojie, Z. (2017). *In vitro* and vivo antioxidant activities of daylily flowers and the involvement of phenolic compounds. *Asia Pacific Clinical Nutrition, 16*, 196-203.

Galoburda, R., Kuka, M., Cakste, I., & Klava, D. (2015). The effect of blanching temperature on the quality of microwave-vacuum dried mushroom cantharellus cibarius. *Agronomy Research, 13*(4), 929-938.

Greco, C., Catania, P., Orlando, S., Vallone, M., & Mammano, M. M. (2024). A sustainable smart dryer for aromatic herbs. Paper presented at the International Mid-Term Conference of the Italian Association of Agricultural Engineering.

Hong, W. X., Jun, W. B., Da, W. S., & Zhen, J. G. (2014). The application of superheated steam impingement blanching (ssib) in agricultural products processing – a review. *Journal of Food Engineering, 132*, 39–47. https://doi.org/10.1016/j.jfoodeng.2014.01.032

Ibrahim, D. (2008). Influence of blanching and slice thickness on drying characteristics of leek slices. *Chemical Engineering and Processing, 47*, 41-47. https://doi.org/10.1016/j.cep.2007.09.002

Jianxin, C., Dawn, E. H., & Vincenzo, D. L. (2005). Effects of the growth retardant paclobutrazol on large-scale micropropagation of daylily (Hemerocallis spp.). *In Vitro Cellular & Developmental Biology - Plant, 41*, 58-62. https://doi.org/10.1079/IVP2004595

Jun, W., Xiao, M. F., Mujumdar, A. S., Jing, Y. Q., Qian, Z., Xu, H. Y., Yan, H. L., Zhen, J. G., & Hong, W. X. (2017). Effect of high-humidity hot air impingement blanching (hhaib) on drying and quality of red pepper (*Capsicum annuum* L.). *Food Chemistry, 220*(2017), 145-152. https://doi.org/10.1016/j.foodchem.2016.09.200

Katarzyna, S., Danuta, K., Małgorzata, M.-K., Barbara, K., Agnieszka, D., & Renata, N. (2019). The essential oil composition of selected hemerocallis cultivars and their biological activity. *Open Chem, 17*, 1412-1422. https://doi.org/10.1515/chem-2019-0160

Szewczyk, K., Miazga-Karska, M., Pietrzak, W., Komsta, Ł., Krzemińska, B., & Grzywa-Celińska, A. (2020). Phenolic composition and skin-related properties of the aerial parts extract of different Hemerocallis cultivars. *Antioxidants, 9*(8), 690. https://doi.org/10.3390/antiox9080690

Kırbaş, İ., Tuncer, A. D., Şirin, C., & Usta, H. (2019). Modeling and developing a smart interface for various drying methods of pomelo fruit (citrus maxima) peel using machine learning approaches. *Computers Electronics in Agriculture, 165*, 1-8. https://doi.org/10.1016/j.compag.2019.104928

Linlin, Z., Hanzhi, F., Min, Z., Bimal, c., Bhesh, B., & Bin, W. (2019). Edible flowers: Review of flower processing and extraction of bioactive compounds by novel technologies. *Food Research International, 126*, 108660. https://doi.org/10.1016/j.foodres.2019.108660

Liu, Y. Q., Wu, Z. L., Li, X. H., Shi, D. Q., Yiu, C. C. Y., Li, B. Z., Huang, Z. M., & Xiao, H. W. (2025). Study on drying behavior, quality attributes, shrinkage modeling and comprehensive evaluation of carrot slices by freeze drying combined with microwave *drying. Drying Technology, 43*(9), 1448-1459.

Liu, Y., & Liao, W. (2025). Ornamental crops: An introduction to bulbous flowers. In Breeding of ornamental crops: Bulbous flowers (pp. 1-38): Springer.

Madurangi, A. D. R., & Marapana, R. A. U. J. (2025). Evaluating the effectiveness of blanching as a pre-treatment to minimize surface white discoloration on pickled carrots. *Research and Innovation in Food Science and Technology, 14*(1), 1-14.

Mahari, H. T., & Mohamed, J. N. (2025). Shelf-life determination of dried onion (*Allium cepa*) and tomato (*Lycopersicon esculentum*) products. *Journal of Food Engineering and Technology, 14*(1), 12-20.

Martínez, S., Roman, C., Andreina, Boubertakh, A., & Carballo, J. (2024). Banana drying: A review on methods and advances. *Food Reviews International, 40*(8), 2188-2226.

Minea, V. (2013). Drying heat pumps–part ii: Agro-food, biological and wood products. *International Journal of Refrigeration*, *36*(3), 659-673.

Mitra, A. C., Jawarkar, M., Soni, T., & Kiranchand, G. R. (2015). Implementation of taguchi method for robust suspension design. Paper presented at the 12th International Conference on Vibration Problems, ICOVP 2015.

Motegaonkar, S., Shankar, A., Tazeen, H., Gunjal, M., & Payyanad, S. (2024). A comprehensive review on carrot (*Daucus carota* L.): The effect of different drying methods on nutritional properties and its processing as value-added foods. *Sustainable Food Technology, 2*(3), 667-688.

Özkan, K. A., Çalışkan, K. G., Adal, S., Süfer, Ö., Tonay, A. N., Delikanlı, K., Berrak, Çelebi, Y., & İnan-Çınkır, N. (2025). A review of emerging technologies on the rehydration behavior of foodstuffs. *Journal of Food Process Engineering*, *48*(2), e70031.

Pathan, M., Parmar, P., Gandhi, R., & Kumar, N. (2025). Effects of blanching parameters and partial drying on the physicochemical properties of sweet potato slices. *Journal of Agricultural Engineering (India), 62*(2), 364-379. https://doi.org/10.52151/jae2025622.1935.

Ratiya, T., Somkiat, P., Jaruwan, K., & Somchart, S. (2011). Determination of effective moisture diffusivity and assessment of quality attributes of banana slices during drying. *Food Science and Technology International*, *44*(2011), 1502-1510. https://doi.org/10.1016/j.lwt.2011.01.003

Salehi, F., Goharpour, K., & Kamran, H. R. (2024). Effects of different pretreatment techniques on the color indexes, drying characteristics and rehydration ratio of eggplant slices. *Results in Engineering, 21*, 101690.

Shenghua, D., Jia, Y., Kejing, A., Yuan, L., & Zhengfu, W. (2012). Effective diffusivities and energy consumption of daylily in microwave drying. *International Journal of Food Science and Technology*, *1*(2012), 1-8. https://doi.org/10.1111/j.1365-2621.2012.03147.x

Sukhcharn, S., Raina, C. S., Bawa, A. S., & Saxena, D. C. (2006). Effect of pretreatments on drying and rehydration kinetics and color of sweet potato slices. *Drying Technology, 24*(2006), 1487–1494. https://doi.org/10.1080/07373930600952834

Taiwo, K. A., & Adeyemi, O. (2009). Influence of blanching on the drying and rehydration of banana slices. *African Journal of Food Science, 3*(10), 307-315.

Wu, B., Bouhile, Y., Guo, Y., Dai, J., Song, C., Cong, L., & Ma, H. (2025). Impact of apple slice thickness and water-soaking pretreatment on catalytic infrared blanching efficiency and subsequent hot air drying performance. *Drying Technology*, *43*(5), 802-822.

Wu, Zhang, Z., Bao, Y., Li, D., Wen, X., Feng, L., Nie, M., Dai, Z., & Xu, Y. (2025). Effects of sodium alginate and calcium on quality attributes of shepherd's purse under ultrasound impregnation during blanching processing. *Food Production, Processing and Nutrition, 7*(1), 16. https://doi.org/10.1186/s43014-024-00292-y

Xie, L., Liu, J., Wu, H., Zhong, Y., Liu, X., Li, G., & Liu, Z. (2024). A comparison analysis of quality and metabolic compounds in lilies with different drying treatments. *Foods*, *13*(14), 2206.

Xing, Y., Zhang, T., Yue, T., Yi, R., Xu, Q., & He, L. (2025). Effect of vacuum microwave drying pretreatment on the quality characteristics and textural structure of new paocai raw materials. *Sustainable Food Technology, 3*(5), 1309-1318. https://doi.org/10.1039/d5fb00108k

Yang, F., Zhang, J., Mujumdar, A. S., Sutar, P. P., Yi, X., Wang, X., Hu, C., Ni, J., & Xiao, H. (2025). Effects of drying methods on drying characteristics and physicochemical quality of turnip slices (*Brassica rapa* L.). *Processes*, *13*(9), 2773.

Yanjun, Z., Robert, H. C., & Muraleedharan, G. N. (2004). Lipid peroxidation inhibitory compounds from daylily (*Hemerocallis fulva*) leaves. *Life Sciences, 75*, 753-763. https://doi.org/10.1016/j.lfs.2004.03.002

Ying, C. W. (2013). In vitro antioxidant capacity of daylily (*Hemerocallis disticha*) flowers cultivated in Taiwan. *Life Science Journal, 10*(3), 1524-1527.

Zhang, Q., Wang, B., Xing, Y., Wang, G., Zhang, X., & Lü, X. (2024). Drying characteristics of sewage sludge pre-conditioned by cao and sawdust under low-temperature drying conditions. *Environmental Technology, 45*(28), 6237-6248.