CELEBES Agricultural 6(2): 66 - 77 February (2026)

Research Article

Characteristics of Passive Drying Model in Bird's Eye Chili and Curly Chili

Karakteristik Model Pengeringan Pasif pada Cabai Rawit dan Cabai Keriting

Risal Nur Rahma Syahrir[1]*, Asnidar Mastam[1], Yulismayanti[1], Andi Anggi Novergi[2]

[1] Study Program of Agricultural Engineering, Department of Agricultural Technology, Faculty of Agriculture, Sam Ratulangi University, 95115, Manado

[2] Study Program of Agricultural Engineering, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University, 90245, Makassar

*email: risalnurrahma@unsrat.ac.id

Received: November, 2025
Accepted: April, 2026
Published: April, 2026

p-ISSN: 2723-7974
e-ISSN: 2723-7966
doi: 10.52045/jca.v6i2.1112

Website:
https://ojs.untika.ac.id/index.php/faperta

Abstract: Chili is a commodity that is susceptible to damage, because of its highwater content, so it is necessary to carry out efficient and effective post-harvest actions through drying methods. Chili drying aims to reduce the water content of the dried material. The purpose of this study was to determine the pattern of water content reduction in bird's eye chili and curly chili and the appropriate drying model to use for chili peppers. The average drying temperature inside the chamber ranger from 39 until 75 C and the total drying time was 21 hours from each treatment. The samples used were two types of chili peppers, namely bird's eye chili and curly chili. The models whose suitability was evaluated were the Newton, Page, Handreson & Pabris models. The Page model showed the best performance in describing the drying behaviour of bird's eye chili and curly chili, with R2 values of 0.9952 and 0.9971, respectively, which were higher than those obtained from the Newton and Henderson & Pabis model.

Keywords: Passive drying, cayenne pepper, dried chili, drying model

Abstrak: *Cabai merupakan komoditas yang rentan terhadap kerusakan, karena kadar air yang cukup tinggi sehingga perlu dilakukan tindakan pasca panen yang efisien dan efektif melalui metode pengeringan. Pengeringan cabai bertujuan untuk mengurangi kadar air bahan yang dikeringkan. Tujuan dari penelitian ini ialah untuk mengetahui pola penurunan kadar air cabai rawit dan cabai keriting serta model pengeringan yang tepat digunakan pada cabai. Suhu pengeringan rata-rata didalam ruang pengering berkisar antara 39 sampai 75 C. Sampel yang digunakan dua jenis cabai, yakni cabai keriting dan cabai rawit. Model yang dievaluasi kesesuainnya adalah model Newton, Page, Handreson & Pabris. Model Page menunjukkan kinerja terbaik dalam menggambarkan perilaku pengeringan cabai rawit dan cabai keriting dengan nilai* R^2 *masing-masing sebesar 0.9952 dan 0.9971, yang lebih tinggi dibandingkan dengan menggunakan model Newton dan Henderson & Pabis.*

Kata Kunci: Pengeringan pasif, Cabai Rawit, Cabai Kering, Model Pengeringan

INTRODUCTION

Red chili (*Capsicum annuum L.*) is one of the vegetable commodities with a relatively high economic value due to its important role in meeting domestic needs as well as serving as an export commodity and a raw material for the food and pharmaceutical. After being harvested, chili peppers continue to undergo respiration, a natural process that cannot be stopped, and they easily experience metabolic changes due to their highwater content. Consequently, they cannot be stored for long in their fresh form (Ridwan et al., 2022).

Citation:
Syahrir RNR, Mastam A, Yulismayanti, Novergi AA. 2026. Characteristics of Passive Drying Model in Bird's Eye Chili and Curly Chili. *CELEBES Agricultural*. 6(2): 66-77. doi: 10.52045/jca.v6i2.1112

In general, chili peppers are still handled in a very simple manner after harvest, which leads to a high rate of damage (Afgani & Ariskanopitasari, 2024). This issue is caused by farmers' limited understanding of postharvest management techniques and the lack of adequate technological infrastructure (Wulandari & Kurniati, 2025). Chili peppers contain a high level of moisture, making them highly perishable (Kusmali et al., 2024). The deterioration of chili peppers can be caused by internal factors within the chili itself or by external factors. Farmers are often reluctant to take the risk of storing their chili harvest because of its perishable nature; therefore, an efficient and effective postharvest handling method such as drying is necessary (Alhanannasir et al., 2024). Bird's eye chili and curly chili were selected in this study because both commodities have different physical characteristics, particularly in size, skin thickness, and surface area, which may influence heat and mass transfer during drying. The comparison of these two chili varieties is expected to provide information on the suitability of a drying model for different chili characteristics.

In addition, studies comparing thin-layer drying models of different chili varieties using a passive direct dryer are still limited. Determination of an appropriate drying kinetic model is important as a fundamental reference for the design and scale-up of solar dryers for agricultural products. The novelty of this study lies in the simultaneous evaluation of two chili varieties dried in a passive dryer by considering different tray positions inside the drying chamber. Based on the explanation above, it is necessary to conduct a study on the passive drying of bird's eye chili and curly chili to determine the moisture reduction pattern of both types of chili and to identify the appropriate drying model that matches the characteristics of bird's eye chili and curly chili.

MATERIALS AND METHODS

Materials and Tools

The materials used in this study were bird's eye chili and curly chili with an average weight of 67.806 g for bird's eye chili and 99.783 g for curly chili. The amount of material used was adjusted to the maximum tray capacity for each commodity being dried. The equipment used in this study included a direct-type passive solar box dryer, a digital scale, a hygro-thermometer, a wire rack, a mobile phone camera, and a laptop.

Procedure Research

Preparation

The preparation carried out in this study included preparing the drying equipment, cleaning the bird's eye chili and curly chili, and selecting chili samples that were as unifor as possible in terms of color, length, and diameter. The trays measuring 25 × 10 cm were weighed using a digital scale before being filled with samples. The chilies were then placed into four trays, consisting of two trays for bird's eye chili and two trays for curly chili. The experiment was conducted using a descriptive experimental design with two replications for each chili variety and tray position. The analysis focused on the determination of drying kinetic model parameters and goodness-of-fit evaluation.

Drying Process

The drying process was carried out following these procedures: The bird's eye chili and curly chili to be dried were prepared, and the drying process was conducted from 9:00 a.m. to 4:00 p.m. The chilies were placed in the dryer with different positions for two replications. The dryer was positioned under direct sunlight. Every 30 minutes, the chilies were removed from the dryer and weighed to determine the sample weight, while the temperature inside the drying chamber was recorded. Once the weight reduction became constant, the chili samples were placed in an oven at 105 °C for 72 hours to obtain their dry weight. After oven drying, the samples were removed and weighed again to determine the total dry weight.

Data Processing

After obtaining the dry weight of the material (the weight of the chili after being dried using a passive dryer), the moisture content on a wet basis was then calculated using the following equation (Irwan et al., 2020):

$$Kabb = \frac{Wt - Wd}{Wt} \times 100\%$$

description:

Kabb = Moisture content on a wet basis (%)
Wt = Initial weight of the material (g)
Wd = Dry weight of the material (g)

After calculating the moisture content of the material, the Moisture Ratio (MR) was then determined using the following equation (Mukhlis et al., 2024):

$$MR = \frac{(Mt - We)}{(M0 - Me)}$$

description:

MR = Moisture Ratio
Mo = Initial moisture content of the material
Mt = Moisture content at time *t*
Me = Equilibrium moisture content (after reaching constant weight)

The thin-layer drying model was obtained by determining the constants *k*, *a*, and *n* for each exponential form (Jassin et al., 2025). The constant values were determined using MS Excel Solver to obtain the coefficient of determination (R^2), and the model with the highest R^2 value was selected as the best model representing the drying characteristics of bird's eye chili and curly chili. The drying models used in this study were the Newton, Henderson & Pabis, and Page models (Mukmin et al., 2021).

Research Flow Diagram

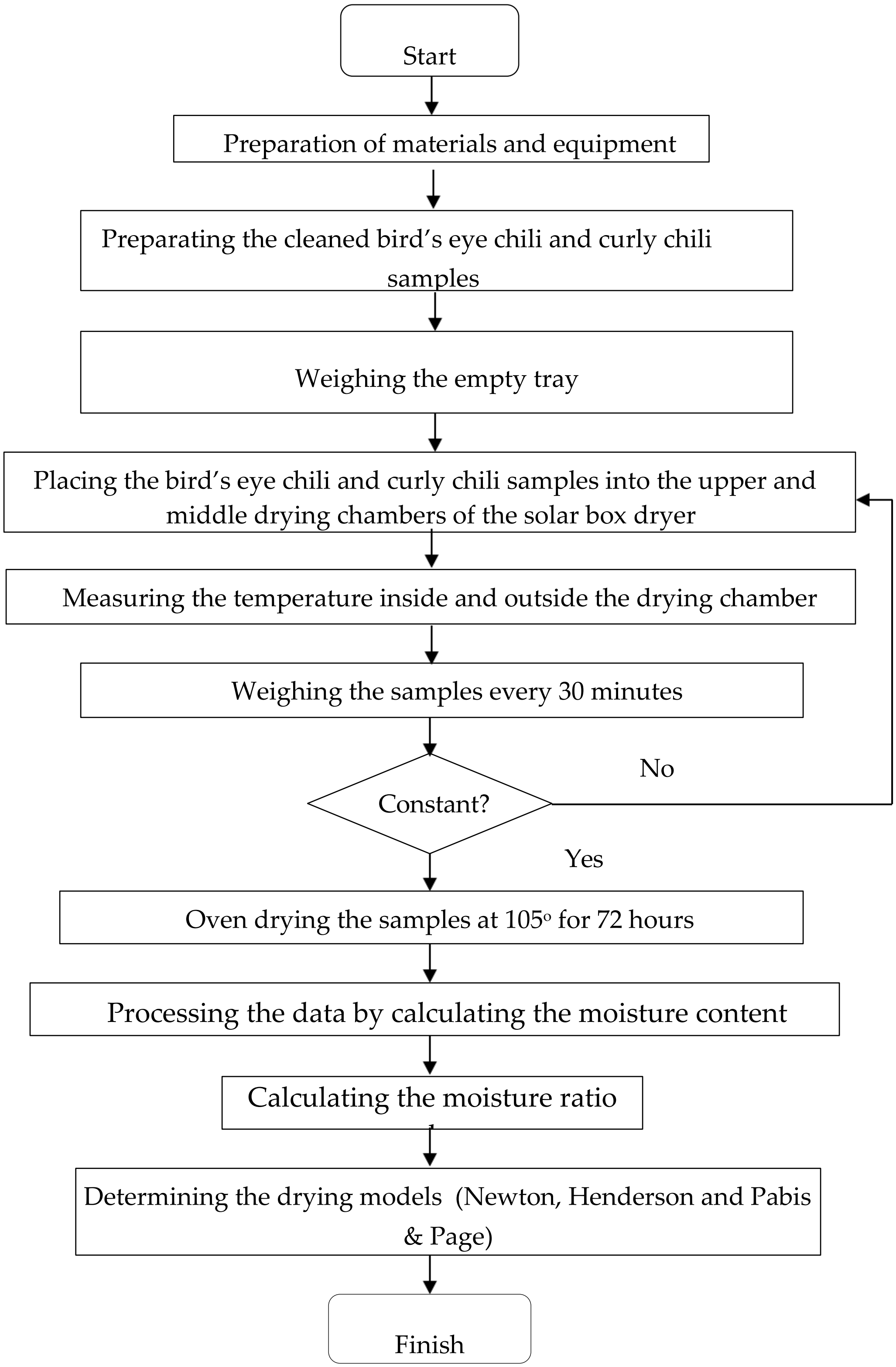

Figure 1. Research flow diagram

RESULTS AND DISCUSSION

Drying Temperature

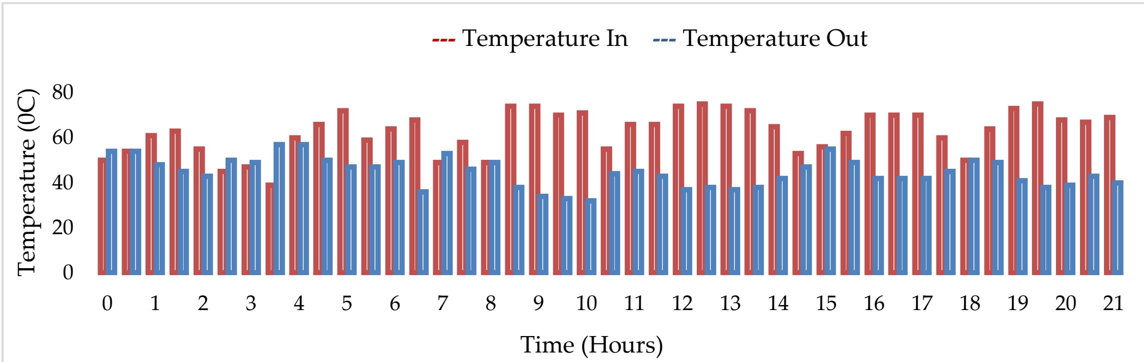

Figure 2. Dryer Temperature Inside and Outside the Dryer in the First Treatment

Based on the graph in Figure 2, it can be seen that the temperature inside the dryer (inlet temperature) was consistently higher than the temperature outside the dryer (outlet temperature). The internal temperature ranged from 39–75 °C, while the external temperature was in the range of 32–57 °C. This condition indicates that the drying chamber was able to maintain a higher internal temperature compared to the surrounding environment (Soekarno et al., 2023). The fluctuation of the internal temperature was quite noticeable, with peaks occurring at hours 5, 9, 12, and between 18–20. This suggests that there was a significant variation in the incoming heat during the drying process (Sari et al., 2020). The temperature difference between the inside and outside remained relatively stable, allowing effective heat transfer and supporting the evaporation of moisture from the chilies.

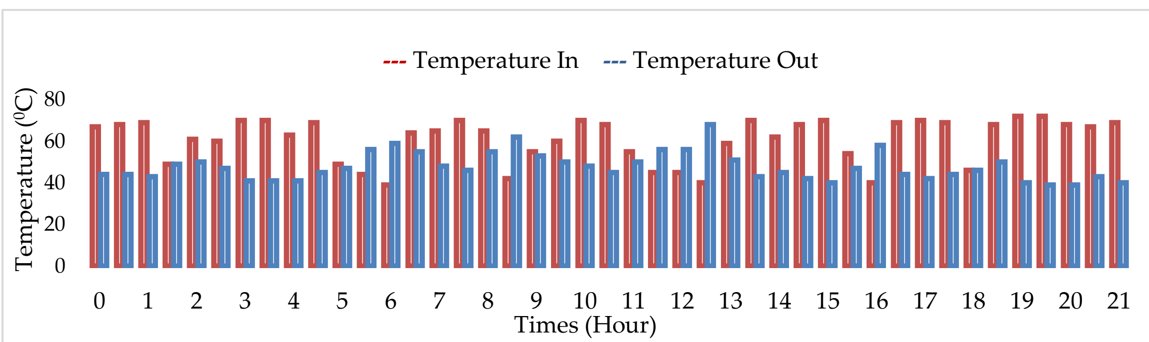

Figure 3. Drying Temperature Inside and Outside the Dryer in the Second Treatment

The graph in Figure 3 shows that the drying temperature pattern in the second treatment also indicated that the internal temperature (in) was higher than the external temperature (out), although the difference was not as large as in the first treatment. The internal temperature ranged from 39–72 °C, while the external temperature was between 39–68 °C.

Based on Figures 2 and 3, it can be observed that the temperature inside the drying chamber (In Temperature) was consistently higher than the temperature outside the drying chamber (Out Temperature) throughout the observation period. This was due to the greenhouse effect of the solar box dryer, which trapped solar heat and increased the internal temperature, thereby accelerating the drying process. In passive solar drying, the temperature of the material in both the first and second treatments increased immediately after being placed inside the drying chamber, with ambient temperatures of 50°C and 67°C, respectively. However, the temperatures inside and outside the dryer were not stable but fluctuated over time due to the influence of sunlight (Irfan & Lestari, 2022). This fluctuation can be seen from the variation in temperature levels at each time interval, which occurred because the intensity of solar radiation received was not constant throughout the day.

Relative Humidity

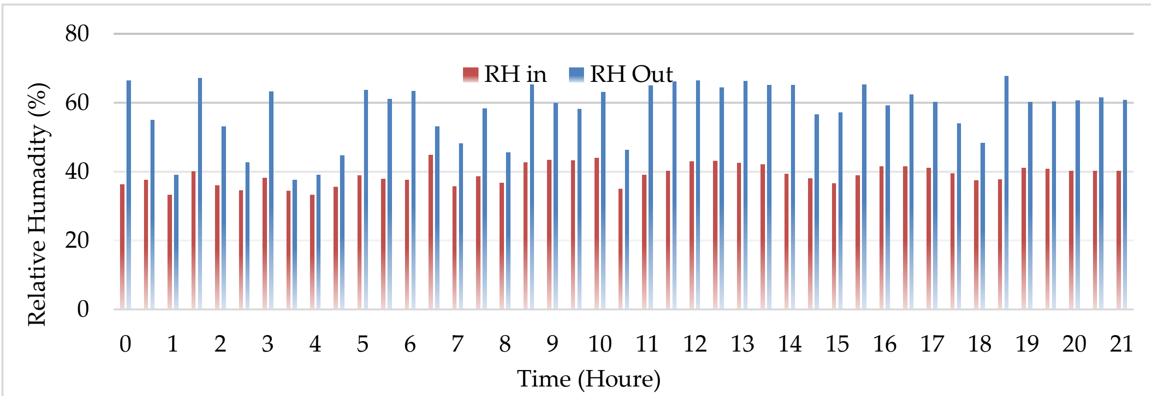

Figure 4. Relative Humidity (RH) Inside and Outside the Dryer in the First Treatment

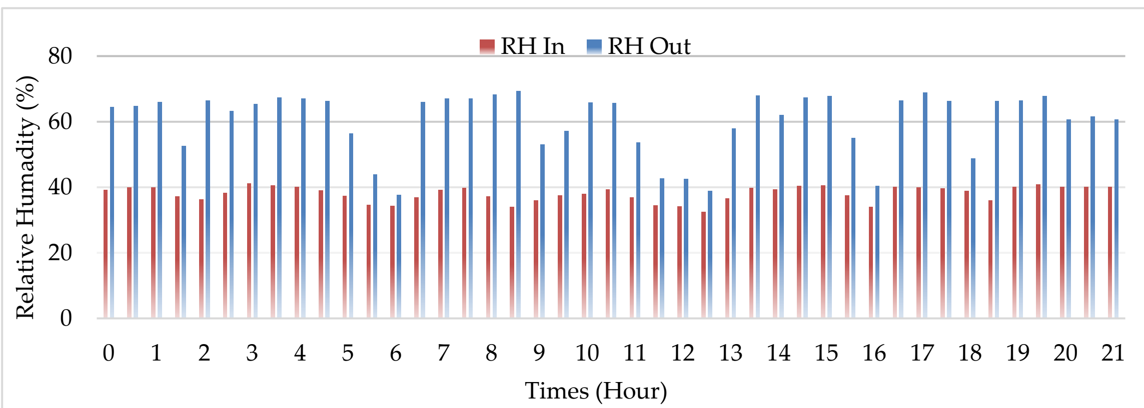

Figure 5. Relative Humidity (RH) Inside and Outside the Dryer in the Second Treatment

Figures 4 and 5 show the relationship between the relative humidity (RH) inside and outside the dryer for each treatment. The results indicate that the relative humidity inside the drying chamber (RH In) was consistently lower than the relative humidity outside the chamber (RH Out). This occurred due to the increase in temperature inside the drying chamber caused by the greenhouse effect of the solar box dryer. As the internal temperature increased, the air's capacity to hold water vapor also increased, resulting in a decrease in relative humidity within the chamber (Rahmah et al., 2024). The drier air inside the dryer had a greater ability to absorb moisture from the chili samples, thereby accelerating the drying process. In both graphs, the relative humidity outside the dryer fluctuated over time, reflecting changes in environmental conditions such as sunlight intensity and ambient temperature. Although the humidity inside the dryer also fluctuated, its values remained consistently lower than the external humidity, confirming the effectiveness of the passive dryer in creating a more favorable drying environment for chilies.

Table 1. Summary of drying air temperature and relative humadity

Treatment	Location	Temperature	Relative Humadity
1	Inside Dryer	39–75	33,2–44,8
1	Outside Dryer	32–57	37, 6–67,7
2	Inside Dryer	39–72	32,4–41,1
2	Outside Dryer	39–68	37, 6–69,3

The summary of drying air conditions in Table 1. indicates that the drying air temperature inside the dryer was consistently higher and the relative humidity was lower than those outside the dryer for both treatments. Higher drying air temperature combined with lower relative humidity increased the driving force for heat and mass transfer and enhanced the moisture removal rate from the chili samples

Moisture Content

The results of the passive drying experiment showed that the chili samples were placed in the upper and middle sections of the drying chamber, with two replications conducted. The following graph illustrates the moisture content reduction pattern of bird's eye chili and curly chili.

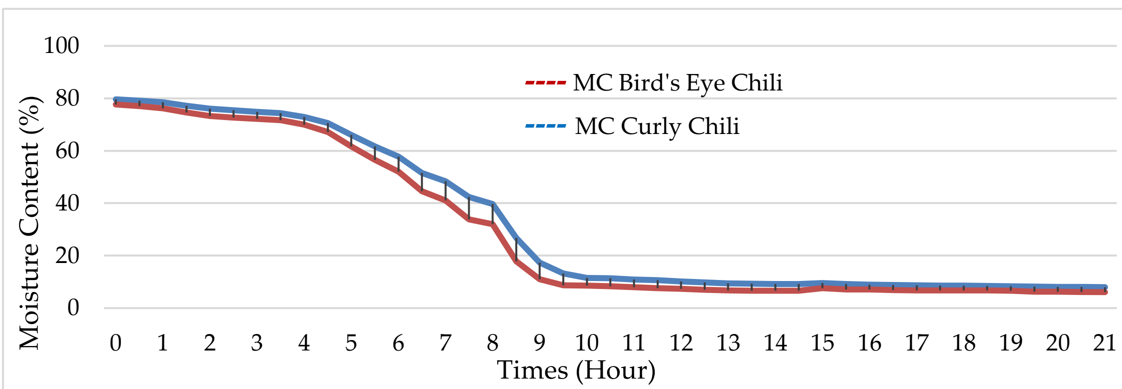

Figure 6. Moisture Content of Bird's Eye Chili and Curly Chili in the First Treatment

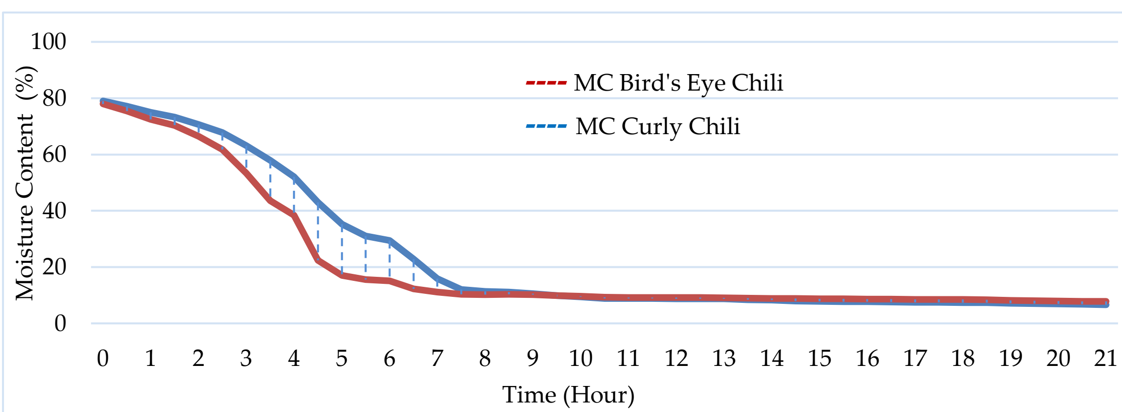

Figure 7. *Moisture content of bird's eye chili and curly chili in the second treatment.*

Figure 6 shows the moisture content reduction pattern of curly chili and bird's eye chili during the drying process, which exhibit similar characteristics. In the initial stage, the moisture content of both chili types near the surface is still high, resulting in a faster rate of moisture reduction. Over time, the drying rate decreases as the surface moisture diminishes. This process causes water diffusion from the inner part of the chili toward the surface to take longer. Based on the research findings, it can be concluded that the drying process using a solar box dryer effectively influences the moisture content of both bird's eye chili and curly chili by evaporating and diffusing the water through the fruit surface into the air until a constant moisture level is achieved. This result is consistent with the study by (Cipta, 2025) which stated that drying aims to reduce the moisture content to a safe level so that the product can be stored longer and is less susceptible to damage.

In the first experiment, the initial moisture content of curly chili was approximately 80%, which decreased to a constant level of about 7%. Meanwhile, bird's eye chili in the same experiment had an initial moisture content of around 79% and reached a constant level of 5%. In the second experiment, curly chili had an initial moisture content of 80% and reached a constant moisture content of 6%, while bird's eye chili started at 79% and stabilized at 5%. Moisture content is an important factor to consider in the storage of agricultural products, including chili. This is consistent with the statement of (Fadhilatunnur et al., 2022), which explains that the drying process aims to reduce the moisture content to a safe limit so that the product can last longer during storage and is less prone to damage. There was no significant comparison between the two types of chili peppers

Moisture Ratio Reduction Pattern

The drying process that has been carried out not only showed a decrease in the moisture content rate of bird's eye chili and curly chili but also a reduction in the Moisture Ratio (MR) value.

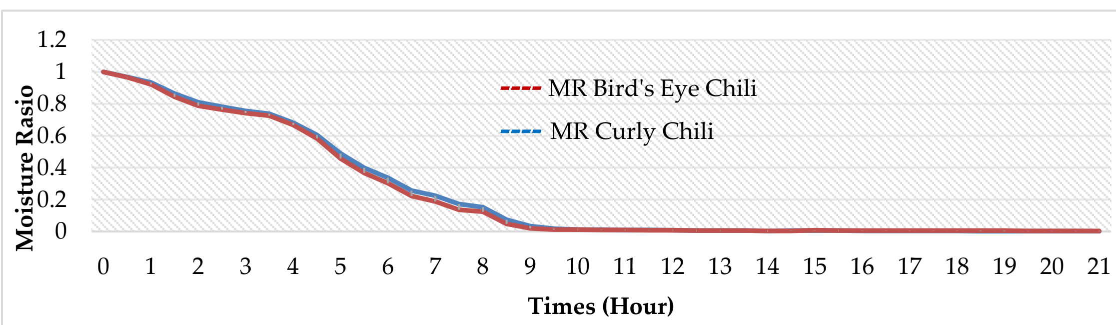

Figure 8. Moisture Ratio of Curly Chili and Bird's Eye Chili in the First Treatment.

Based on Figures 8 and 9, which show the relationship between Moisture Ratio (MR) and time during the drying process, it can be concluded that the decrease pattern of MR for curly chili (MR C.K) and bird's eye chili (MR C.R) is nearly identical. As shown in the figures, the MR value starts at 1 and gradually decreases over time. This result is consistent with the findings of (Ilham, 2025) who stated that as drying time increases, the MR value tends to decrease. The decline occurs rapidly during the initial hours of drying, which aligns with the moisture content reduction pattern. After approximately 8–10 hours, the rate of MR decrease slows significantly until it approaches a value close to zero, indicating that the drying process has reached its final or equilibrium stage.

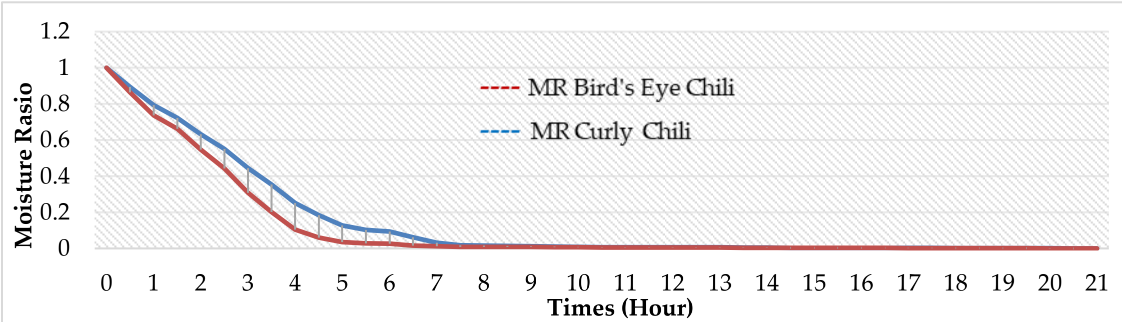

Figure 9. Moisture Ratio of Curly Chili and Bird's Eye Chili in the Second Treatment.

The similar MR reduction patterns observed in both chili types indicate that they have comparable drying characteristics. The MR values are then used to determine the most suitable drying model, where the model with the highest R^2 value is selected to represent the drying behavior of bird's eye chili and curly chili (Yosika et al., 2020).

Drying Model Evaluation

Testing of the drying model on bird's eye chili and curly chili was conducted using three models, namely Page, Newton, and Henderson and Pabis.

Table 2. Analysis results of the equation models for bird's eye chili and curly chili.

Model	Equation	Sample	A	K	N	R^2
Newton	MR=exp (-kt)	Curly chilies U1		0,190275		0,9530
		Curly chilies U2		0,325431		0,9821
		Average		0,257853		0,96755
		Bird's Eye chili U1		0,198656		0,9531
		Bird's Eye chili U2		0,414046		0,9773
		Average		0,306351		0,96520
Page	MR=exp (-kt^n)	Curly chilies U1		0,025175	2,108804	0,9962
		Curly chilies U2		0,171097	1,486017	0,9979
		Average		0,098136	1,79741	0,99705
		Bird's Eye chili U1		0,028568	2,085289	0,9948
		Bird's Eye chili U2		0,228153	1,547439	0,9956

		Average		0,128361	1,816364	0,99520
Henderson and Pabris	MR= a exp(-kt)	Curly chilies U1	1,186784	0,219507		0,9584
		Curly chilies U2	1,096747	0,352532		0,9840
		Average	1,141765	0,28602		0,97120
		Bird's Eye chili U1	1,17777	0,227575		0,9578
		Bird's Eye chili U2	1,090225	0,445608		0,9789
		Average	1,133997	0,336592		0,96835

Table 2 shows the constant values for each of the tested models. From the test results, it can be seen that the Page model has the highest R^2 value compared to the Newton and Henderson & Pabis models. This indicates that the Page model is the best model to describe the decrease in moisture content and Moisture Ratio (MR) during the drying of bird's eye chili and curly chili, in accordance with the study by (Irfan et al., 2021), which stated that the Page model is the most suitable for representing the drying characteristics of chili. After the coefficient of determination (R^2) value is obtained, the root mean square error (RMSE) and chi-square (χ^2) values are calculated as additional parameters to evaluate the level of agreement between the moisture ratio values from observations and the model prediction results.

Table 3. Value root mean-square error (RMSE) and chi-square (χ^2)

Material	RMSE	X^2
Bird's Chili	0,0452	0,00214
Curly Chili	0,0336	0,00118

Based on the constants k, a, and n from Table 1, the predicted Moisture Ratio (MR) values were calculated for each sample (bird's eye chili and curly chili). In addition to the coefficient of determination (R^2), model validation was performed using the root mean square error (RMSE) and chi-square (χ^2). The Page model produced low RMSE values of 0.0336 for bird's eye chili and 0.0452 for curly chili, with corresponding χ^2 values of 0.00118 and 0.00214. These results indicate a good agreement between the experimental and predicted moisture ratio data, confirming the suitability of the Page model to describe the drying behaviour of both chili varieties under passive drying conditions.

CONCLUSIONS

Based on the study conducted on bird's eye chili and curly chili, it can be concluded that the moisture ratio reduction patterns of both types of chili during the drying process were relatively similar. At the beginning of the drying process, the decrease in moisture content occurred rapidly due to the high initial water content, but the drying rate gradually slowed down as the moisture content within the chilies decreased. Among the three drying models tested—Page, Newton, and Henderson & Pabis—the Page model was identified as the most suitable for representing the moisture reduction pattern of bird's eye chili and curly chili, as it produced the highest coefficient of determination (R^2) value.

REFERENCE

Afgani, C. A., & Ariskanopitasari. (2024). Sosialisasi Penanganan Pascapanen Buah Cabai Merah Di Sernu Labu Badas Kabupaten Sumbawa. *Jurnal Agro Dedikasi Masyarakat (JADM)*, *5*(1), 1–6. http://112.78.38.8/index.php/JADM/article/view/23437

Alhanannasir, Sebayang, N. S., Yani, A. V, Yunita, F., Minarni, R., Amelia, P., Saputra, D., & Tino. (2024). Pengelolahan Pangan dengan Cara Pengeringan. *Prosiding Seminar Nasional Biotik*, *12*(1), 103–109.

Cipta, A. M. (2025). *Analisis Teoretis Desain Alat Pemanas Tenaga Surya dalam Menunjang Efisiensi Pengeringan Gabah*. *1*(3), 62–68.

Fadhilatunnur, H., Subarna, Murtadho, Z., & Muhandri, T. (2022). Pengeringan Cabai Merah (*Capsicum annuum* L.) dengan Kombinasi Oven Microwave dan Kipas Angin. *Jurnal Mutu Pangan : Indonesian Journal of Food Quality*, *9*(1), 26–35. https://doi.org/10.29244/jmpi.2022.9.1.26

Ilham. (2025). *Pengaruh Blansir terhadap Pengeringan Cabai Rawit (Capsicum frutescens L .) (Effect of Blanching on Drying of Cayanne Pepper (Capsicum frutescens L .))*. *18*(01).

Irfan, A. M., & Lestari, N. (2022). Pemodelan Matematis Kinetika Pengeringan Cabai Merah Dengan Perlakuan Blansing Suhu Rendah. *Jurnal Ilmiah Rekayasa Pertanian Dan Biosistem*, *10*(1), 98–115. https://doi.org/10.29303/jrpb.v10i1.328

Irfan, A. M., Lestari, N., Arimansyah, A., & Rasyid, A. R. (2021). Kinetika Pengeringan Cabai dengan Perlakuan Blansing Suhu Rendah-Waktu Lama. *AGRITEKNO: Jurnal Teknologi Pertanian*, *10*(1), 24–35.

Irwan, Muhidong, J., & Iqbal. (2020). Passive Drying of Yum Tuber Slices (Dioscorea alata L.). *Jurnal Agritechno*, *13*(2), 127–134. https://doi.org/10.20956/at.v13i1.346

Jassin, E., Muhtar, I., Saleh, R., Ahmad, I., Makassar-parepare, A. J. P., & Pangkep, K. M. (2025). *Optimasi Parameter Kinetika Pengeringan Buah Mengkudu (Morinda citrifolia) dengan Pendekatan Solver Tools*. *4*(April).

Kusmali, M., Gumaran, S., Harmiansyah, H., Fil'aini, R., Utari, N. W., Dermawan, M., & Bossa Samang, A. M. (2024). Perubahan Mutu Fisik Cabai Merah Keriting (*Capsicum annuum* L.) Menggunakan Berbagai Jenis Kemasan Plastik pada Penyimpanan Suhu Rendah. *Jurnal Pertanian Agros*, *26*(2), 531. https://doi.org/10.37159/jpa.v26i2.4607

Mukhlis, A. M. A., Sukainah, A., Putra, R. P., & Annisa, K. (2024). Model Kinetika Pengeringan Ubi Jalar Ungu (*Ipomoea batatas*) Menggunakan Cabinet Dryer. *Jurnal Pendidikan Teknologi Pertanian*, *10*(1), 117–126. https://doi.org/10.26858/jptp.v10i1.2933

Mukmin, Muhidong, J., & Azis, A. (2021). Evaluasi Kinerja Model Page pada Pengeringan Lapisan Tipis Umbi Iles-Iles. *Jurnal Agritechno*, *14*(01), 18–25.

Rahmah, S. A., Titahelu, N., & Simanjuntak, A. (2024). Analisis Efektivitas Pengering Konvektif Limbah Panas Rumput Laut Dengan Kelembaban Relatif Berbeda. *Journal*

Teknik Mesin, Elektro, Informatika, Kelautan Dan Sains, *4*(1), 16–30. https://doi.org/10.30598/metiks.2024.4.1.16-30

Ridwan, M., Sabahannur, S., & Alimuddin, S. (2022). Pengaruh Pendinginan Awal (Pre-Cooling) dan Konsentrasi CaCl2 Terhadap Umur Simpan dan Kualitas Cabai Merah Besar (*Capsicum annuum* L.). *AGrotekMAS Jurnal Indonesia: Jurnal Ilmu Peranian*, *3*(2), 56–67. https://doi.org/10.33096/agrotekmas.v3i2.247

Sari, D. K., Affandi, D. R., & Prabawa, S. (2020). Pengaruh Waktu dan Suhu Pengeringan Terhadap Karakteristik Teh Daun Tin (*Ficus carica* L.). *Jurnal Teknologi Hasil Pertanian*, *12*(2), 68. https://doi.org/10.20961/jthp.v12i2.36160

Soekarno, S., Nadzirah, R., Indarto, I., Lestari, N. P., Bahariawan, A., & Karimah, N. (2023). Pengendalian Suhu Ruang pada Mesin Pengering Vertikal Tipe Rak (Vertical Tray Dryer) dalam Pengeringan Biji Jagung (*Zea mays* L.). *Jurnal Ilmiah Rekayasa Pertanian Dan Biosistem*, *11*(1), 113–124. https://doi.org/10.29303/jrpb.v11i1.454

Wulandari, E., & Kurniati, E. (2025). Karakteristik Pertanian Di Indonesia: Antara Tradisi, Tantangan Struktural, Dan Peluang Transformasi. *Jurnal Ekonomi Pertanian Dan Agribisnis*, *2*(1), 57–72. https://ejurnal.suaninstitute.org/JEPA/article/view/97/75

Yosika, N. ida winni, Hawa, L. C., Hendrawan, Y., Keteknikan, J. T., Teknologi, P.-F., Brawijaya, P.-U., Veteran -Malang, J., & Korespondensi, P. (2020). Karakteristik Pengeringan Cabai Puyang (*Piper retrofractum* Vahl.) Menggunakan Pengeringan Alami (Open Sun Drying). *Jurnal Teknologi Pertanian*, *21*(3), 165–174.