8th European Drying Conference

A presentation

on

Effect of solar radiation and full spectrum artificial sun light on drying and textural characteristics of Asian white radish (*Raphanus sativus* L.)

Presented by
Pratik Nayi (巴庫馬)
P10922033

Advisor
Prof. Ho-Hsien Chen (陳和賢)

Department of Tropical Agriculture and International Cooperation,
National Pingtung University of Science and Technology, 1 Shuefu Road, Neipu, Pingtung,91201, Taiwan

CONTENTS

Introduction

- Asian white radish is a popular root vegetable throughout Asia.
- It is processed into a range of fresh, dried, salted and pickled products.
- Drying is a common method used in the processing of white radish where the water content is reduced, either by mechanical driers or by osmosis, with high concentrations of chemical solutes.
- Solar/Sun drying is the oldest and most economical drying method.

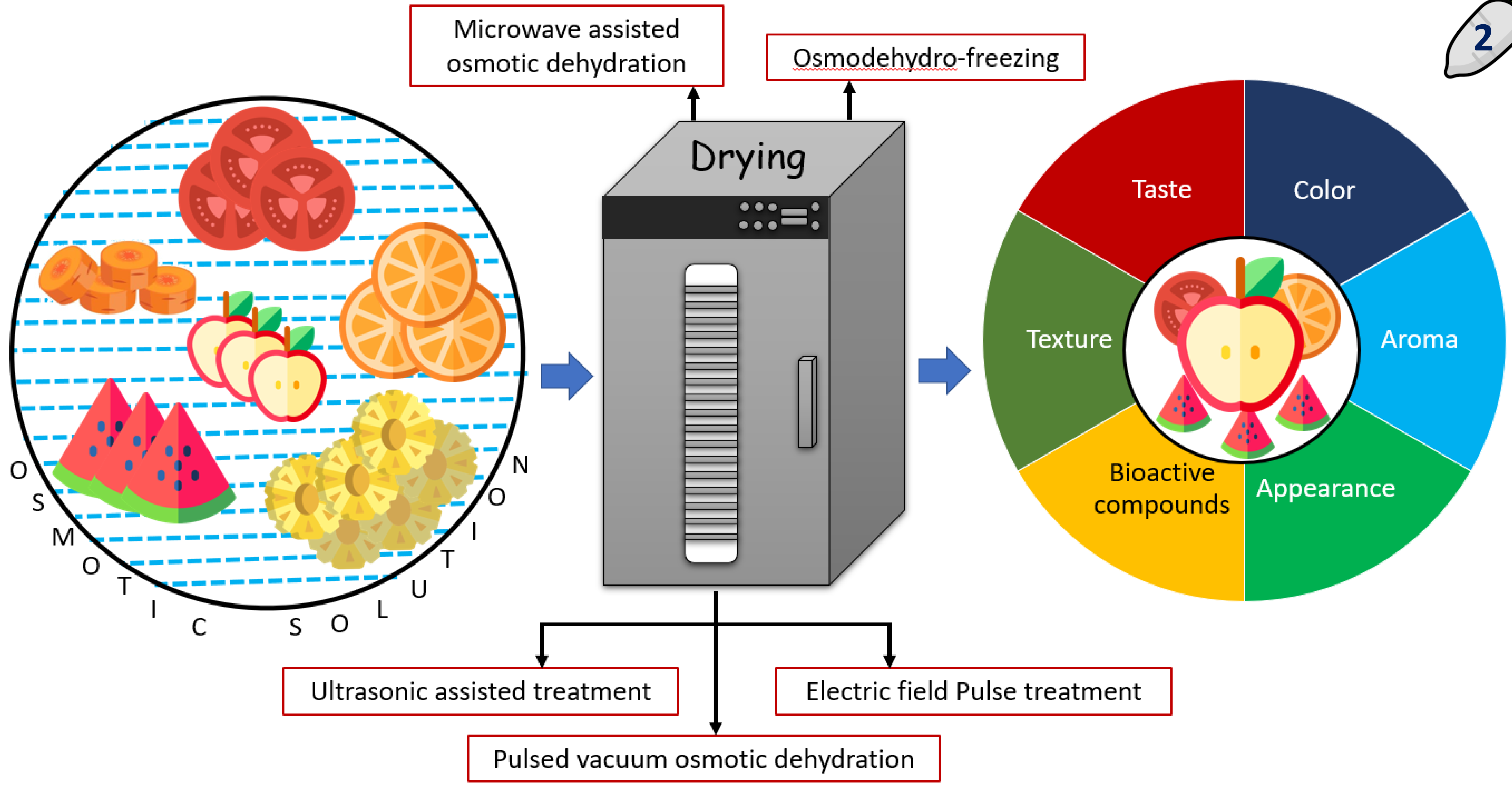
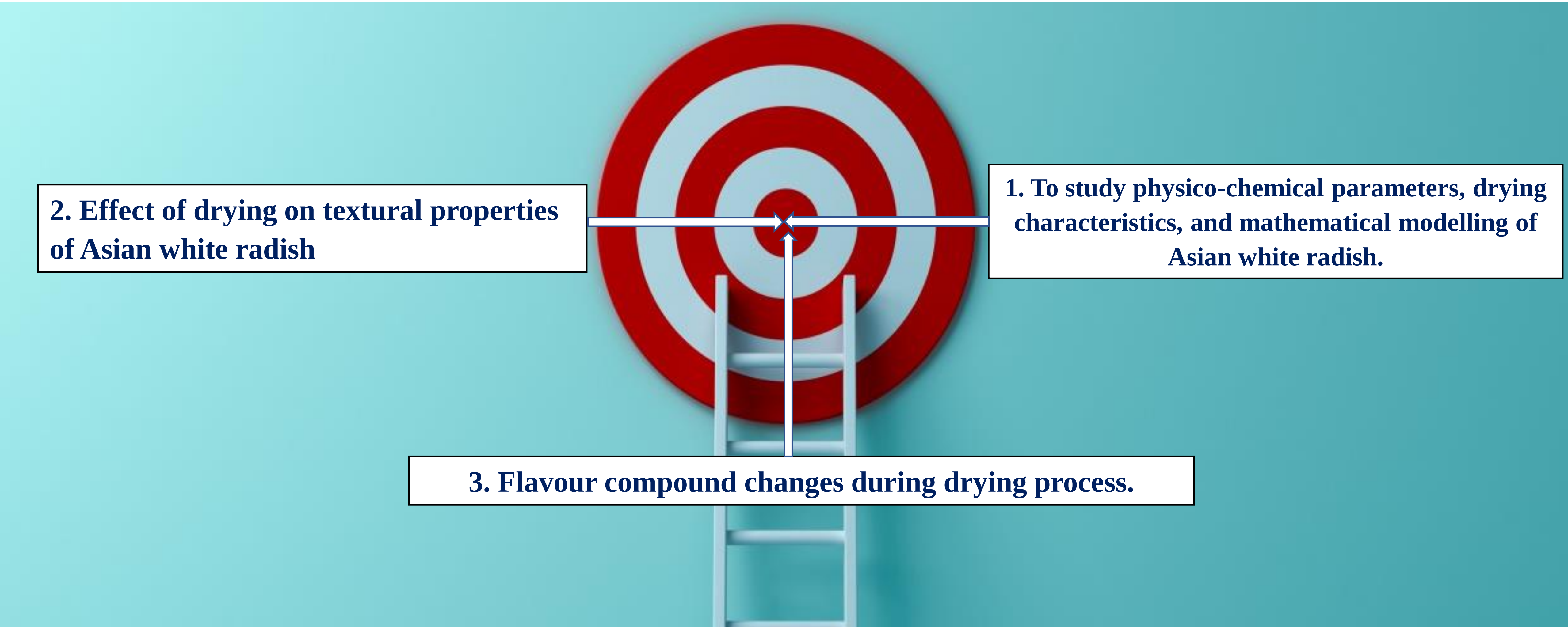


Figure 1. Osmotic dehydration of fruits and vegetables.

(Pandiselvam et al., 2021)

- The food industries are looking for potential preservation methods for fruits and vegetables.
- The combination of osmosis and drying has proved the efficient method to improve the food quality.
- Osmotic dehydration is a mass transfer process.
- Advanced osmotic dehydration techniques can improve the nutritional quality (bioactive) and sensory properties.
- Emerging osmotic dehydration technologies can preserve the structure of fruit tissue.

(Pandiselvam et al., 2021)



1. To study physico-chemical parameters, drying characteristics, and mathematical modelling of Asian white radish.

2. Effect of drying on textural properties of Asian white radish

3. Flavour compound changes during drying process.

Materials and methods

- Fresh Asian white radishes
- Washing
- Peeling
- Cutting in slices
- Adding Salt (25g/100g)
- Pressing by cement blocks (48 to 72 h)
- Remove excess water
- Drying

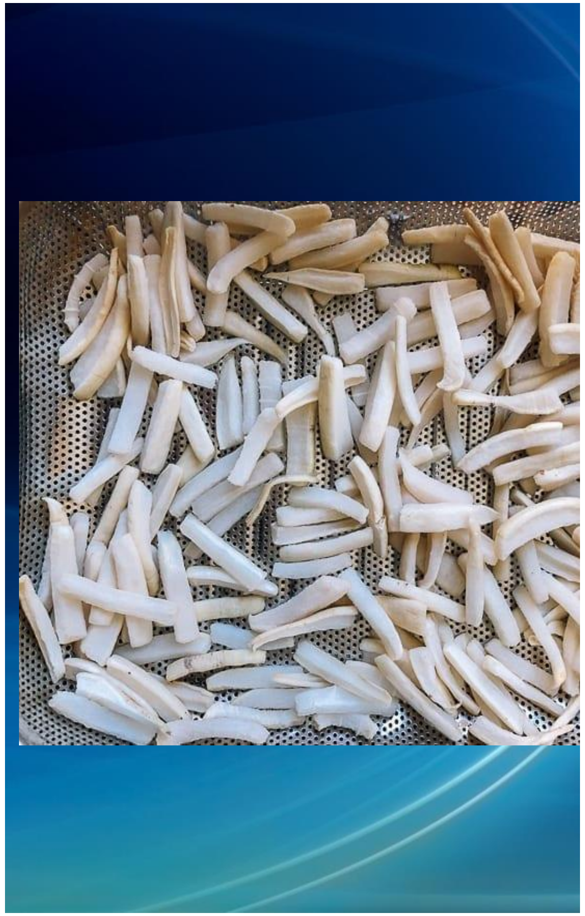


Figure 2. Sample preparation

Coogan and Wills (2002)

Experiment outline

Radish sample

↓

Adding salt (25g/100 g of radish)

↓

Keep overnight

↓

Dry up to 60 % moisture content

After drying

1. Moisture content
2. Drying rate
3. Moisture ratio
4. Drying kinetics

1. Color
2. Water activity
3. TPA (Texture profile analysis)
4. SEM analysis

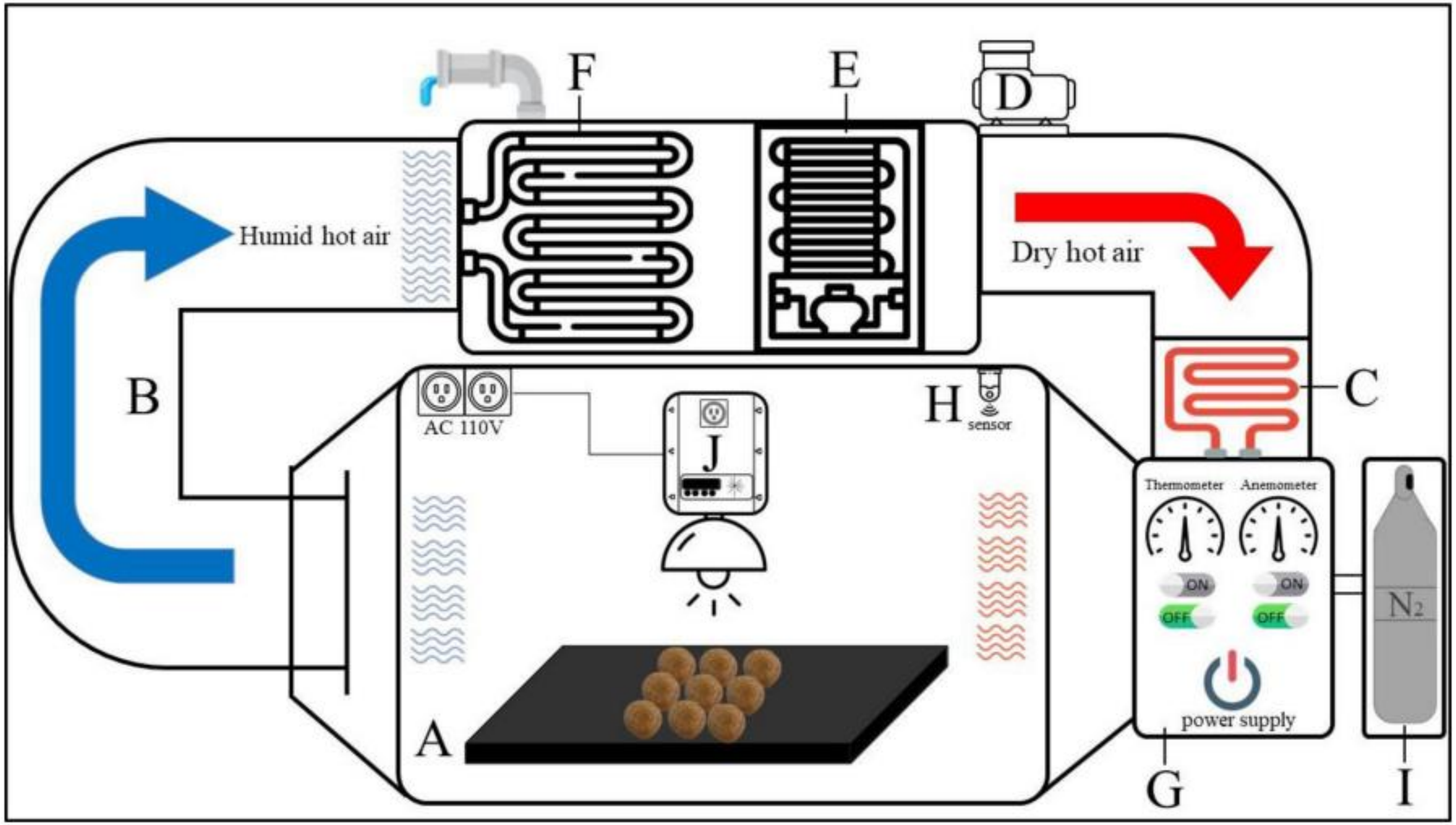
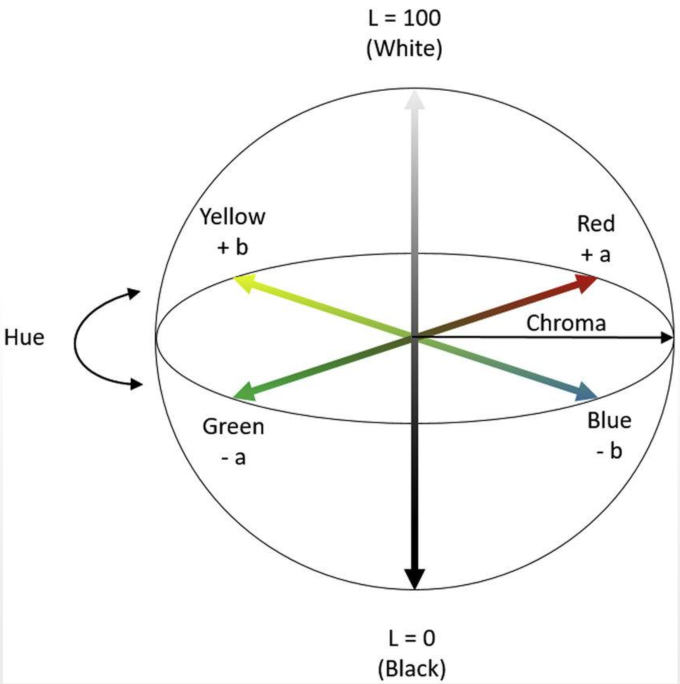


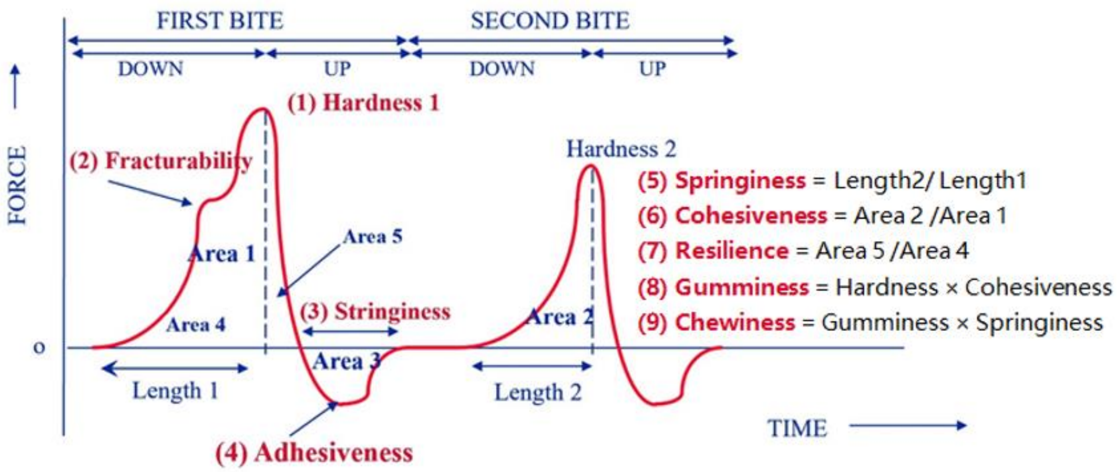
Figure 3. The schematic diagram of a patented photocatalytic closed-type dryer. (A) Drying chamber; (B) airflow duct; (C) heater; (D) compressor; (E) condenser; (F) evaporator; (G) control panel; (H) temperature sensor; (I) N2 gas supply device; (J) artificial sun lamp and assembly

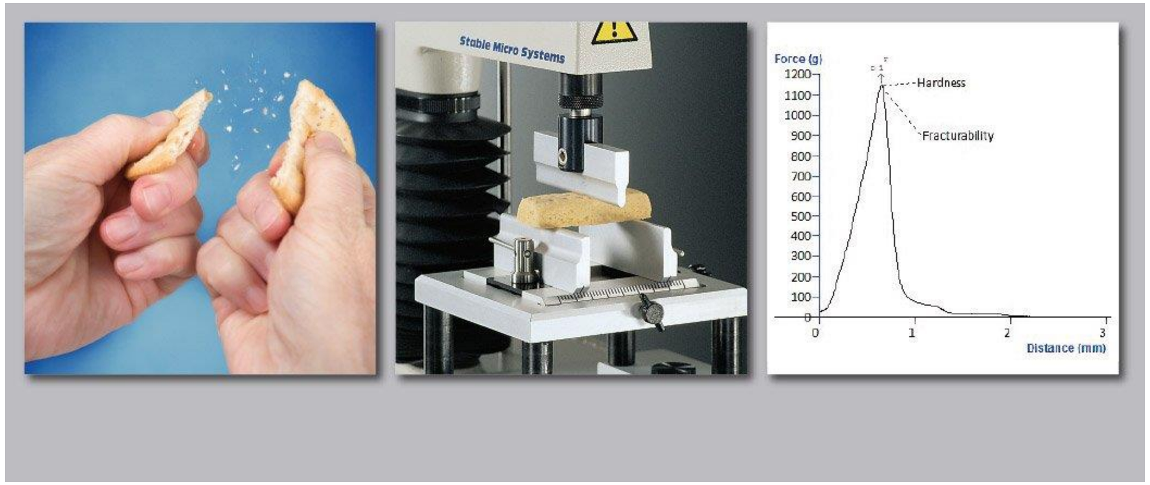


Color scale

Colorimeter

Water activity (Aw) meter





Texture Profile Analyzer (TPA)

Table 1. Commonly studied thin-layer drying models

Models	Expressions
Page	$MR = exp\ (-k_0 t^n)$
Modified Page	$MR = exp\ (-(k_0 t)^n)$
Lewis/Newton	$MR = exp\ (-k_0 t)$
Henderson and Pabis	$MR = A_0 exp\ (-k_0 t)$
Logarithmic	$MR = A_0 exp\ (-k_0 t) + A_1$
Two term	$MR = A_0 exp\ (-k_0 t) + A_1 exp\ (-k_1 t)$
Two-term exponential	$MR = A_0 exp\ (-k_0 t) + (1 - A_0) exp\ (-k_0 A_0 t)$
Wang and Singh	$MR = 1 + A_0 t + A_1 t^2$
Midilli and Kucuk	$MR = A_0 exp\ (-k_0 t^n) + A_1 t$
Diffusion approach	$MR = A_0 exp\ (-k_0 t) + (1 - A_0) exp\ (-k_0 A_1 t)$

Results and Discussion

Table 3. Initial Moisture Content (IMC) of commercial and fresh Asian white radish

Sr. No	Commercial (IMC) Sample wt	Commercial (IMC) Final wt	Commercial (IMC) MC	Fresh (IMC) Sample wt	Fresh (IMC) Final wt	Fresh (IMC) MC
1	7.76	2.71	65.08	9.20	0.51	94.46
2	7.24	2.44	66.30	9.76	0.53	94.57
3	7.75	2.61	66.32	9.75	0.54	94.46
		Avg MC	**65.90**		**Avg MC**	**94.50**

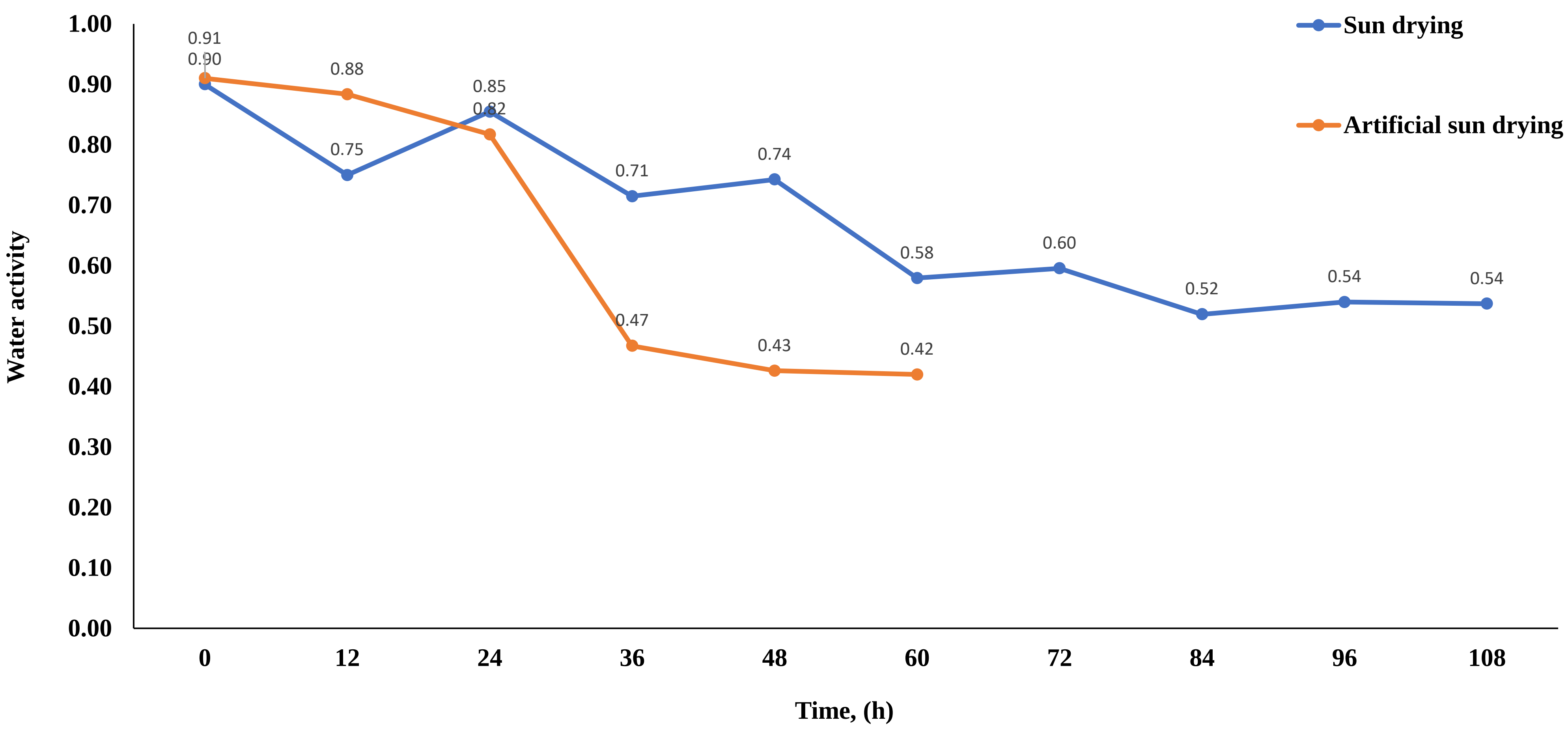
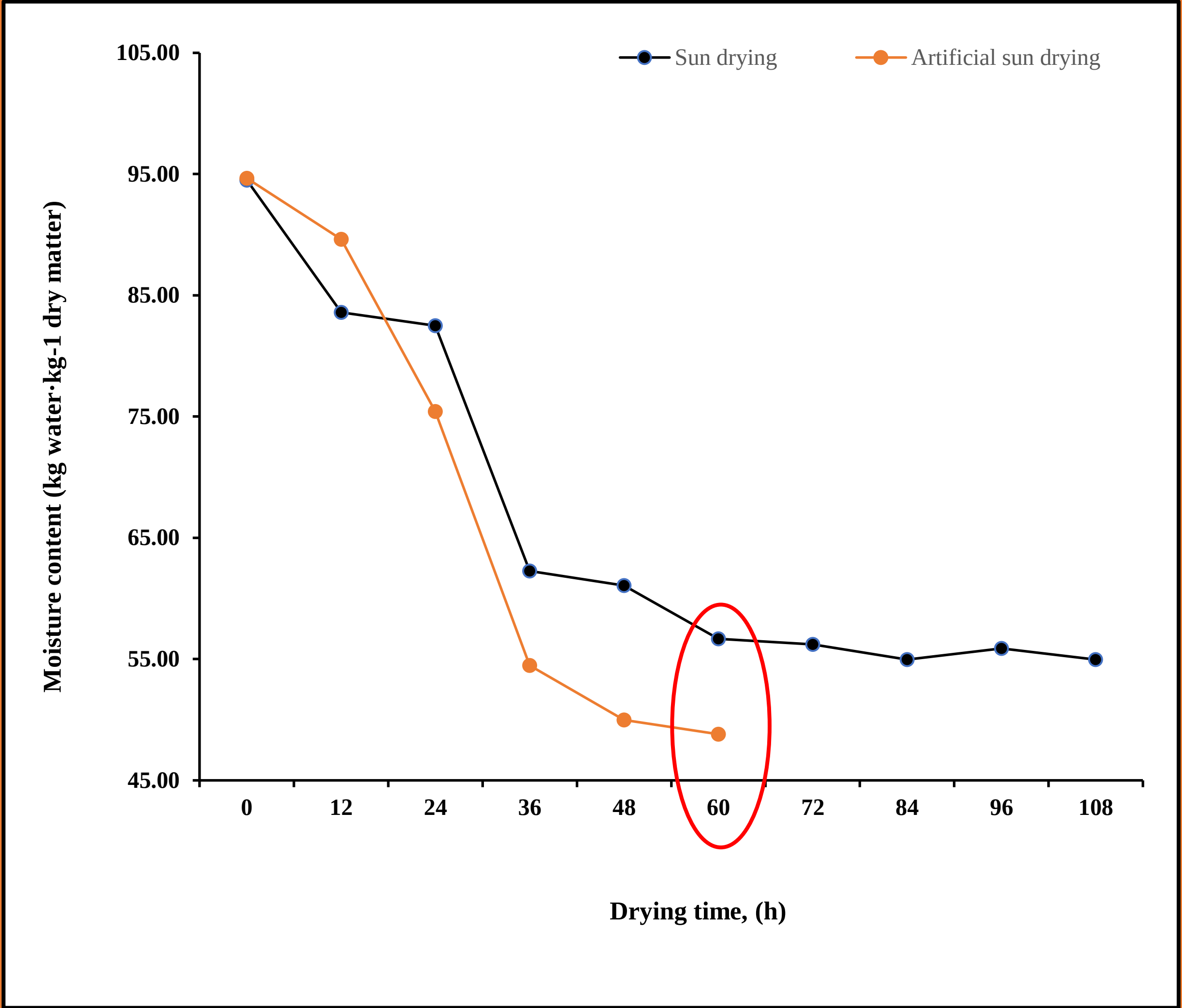


Figure 4. Water activity during sun and artificial sun drying of Asian white radish



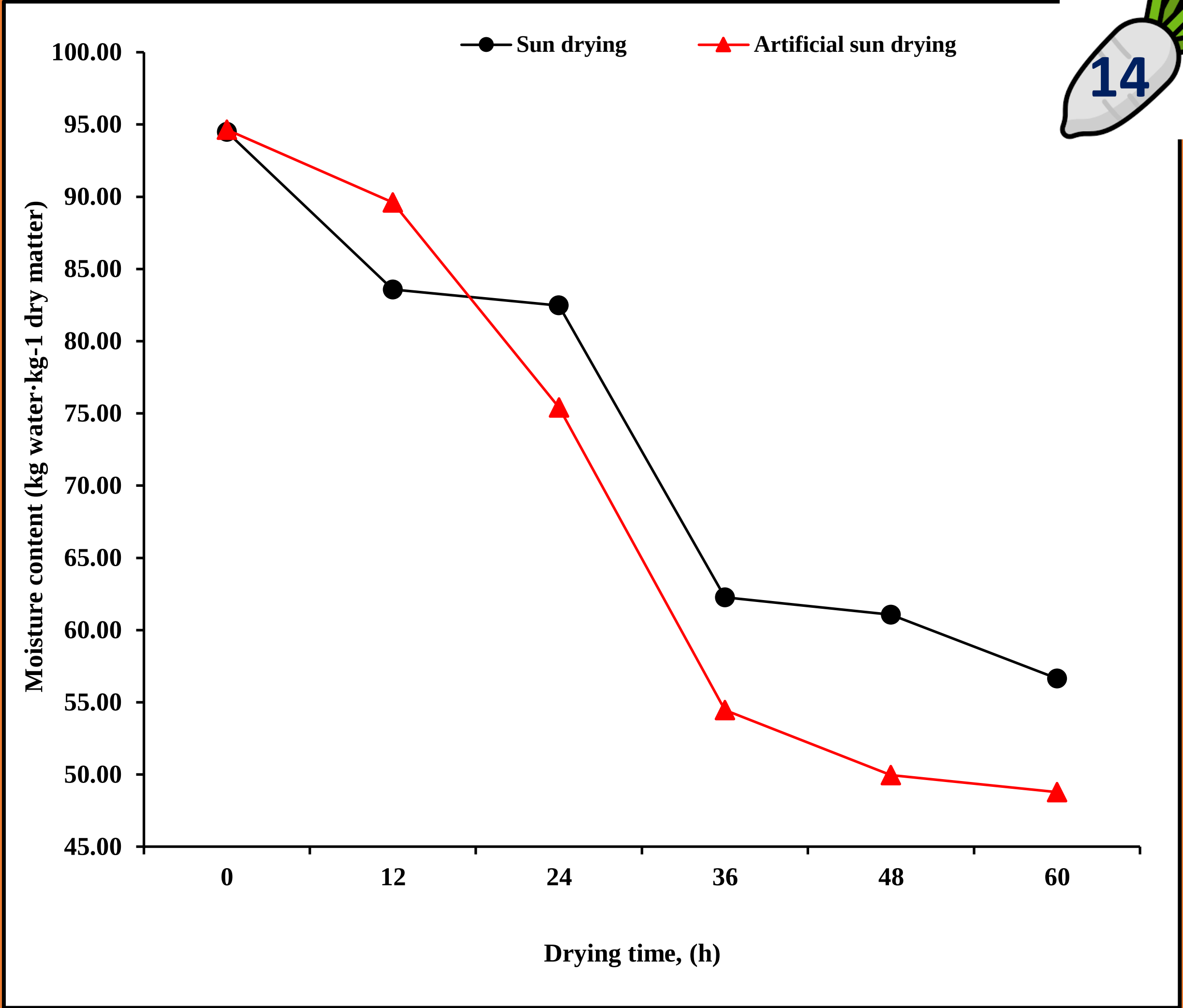


Figure 5. Drying characteristics of sun drying and artificial sun drying of Asian white radish

Table 4. Model parameters for the dried Asian white radish via artificial sun drying

Sr. No.	Model Name	R^2	χ^2 (x10)	RMSE
1	Lewis	0.99412	0.00449	0.02050
2	Page	0.99549	0.00349	0.01790
3	Henderson	0.99514	0.00377	0.01862
4	Logarithmic	0.99699	0.00248	0.01439
5	Two Term	0.99713	0.00242	0.01422
6	Wang & Singh	0.98427	0.01201	0.03241
7	Simplified Ficks	0.99514	0.00377	0.01862
8	Approx Diffusion	0.99411	0.00461	0.02050
9	Modified Page	0.99549	0.00349	0.01790
10	Verma	0.99545	0.00360	0.01785
11	Midilli	0.99975	0.00021	0.00423
12	**Hii**	**0.99976**	0.00021	**0.00409**

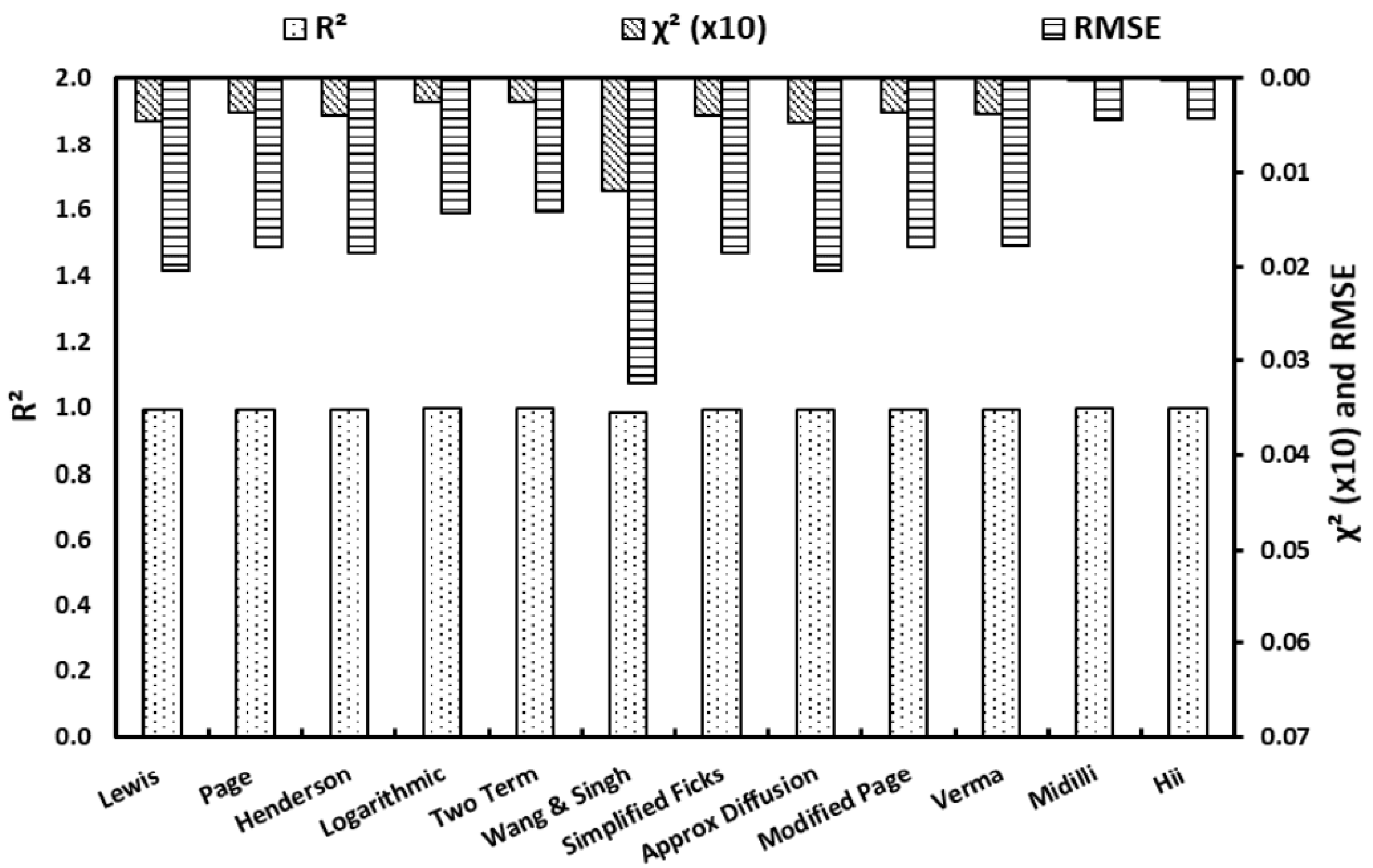


Figure 6. Overall average values of statistical results for different models

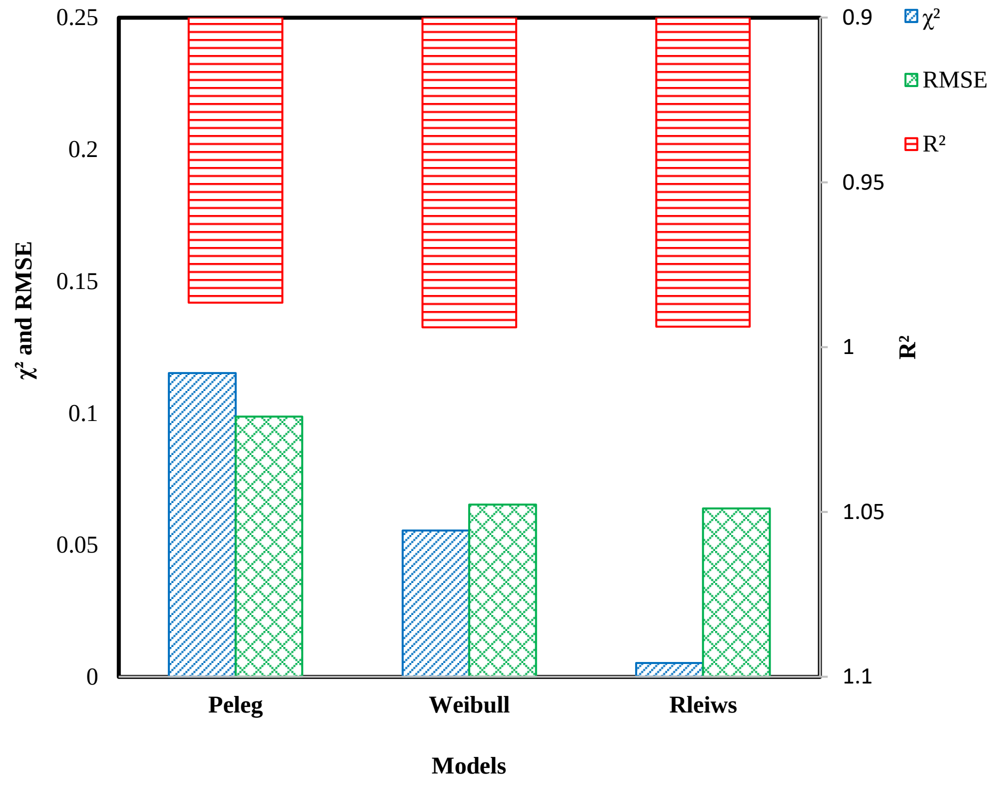


Figure 7. Performance of models for rehydration characteristics

Table 5. Effect of osmotic drying on loss of MTBITC in white radish roots by application of sodium chloride under 12 kg pressure for 72 h at 20 °C

Salt level	MTBITC	Water
	Loss (%)	Loss (%)
0%	15±2.5[a]	3±2.7
5%	22±5.2	46±3.2
15%	38±4.6	49±8.6
25%	47±5.8	54±3.8

[a] Mean±standard deviation ($n=9$ replicates/treatment).

The primary compound responsible for the flavour of white radish, 4-methylthio-3-trans-butenyl isothiocyanate (MTBITC)

Coogan and Wills (2002)

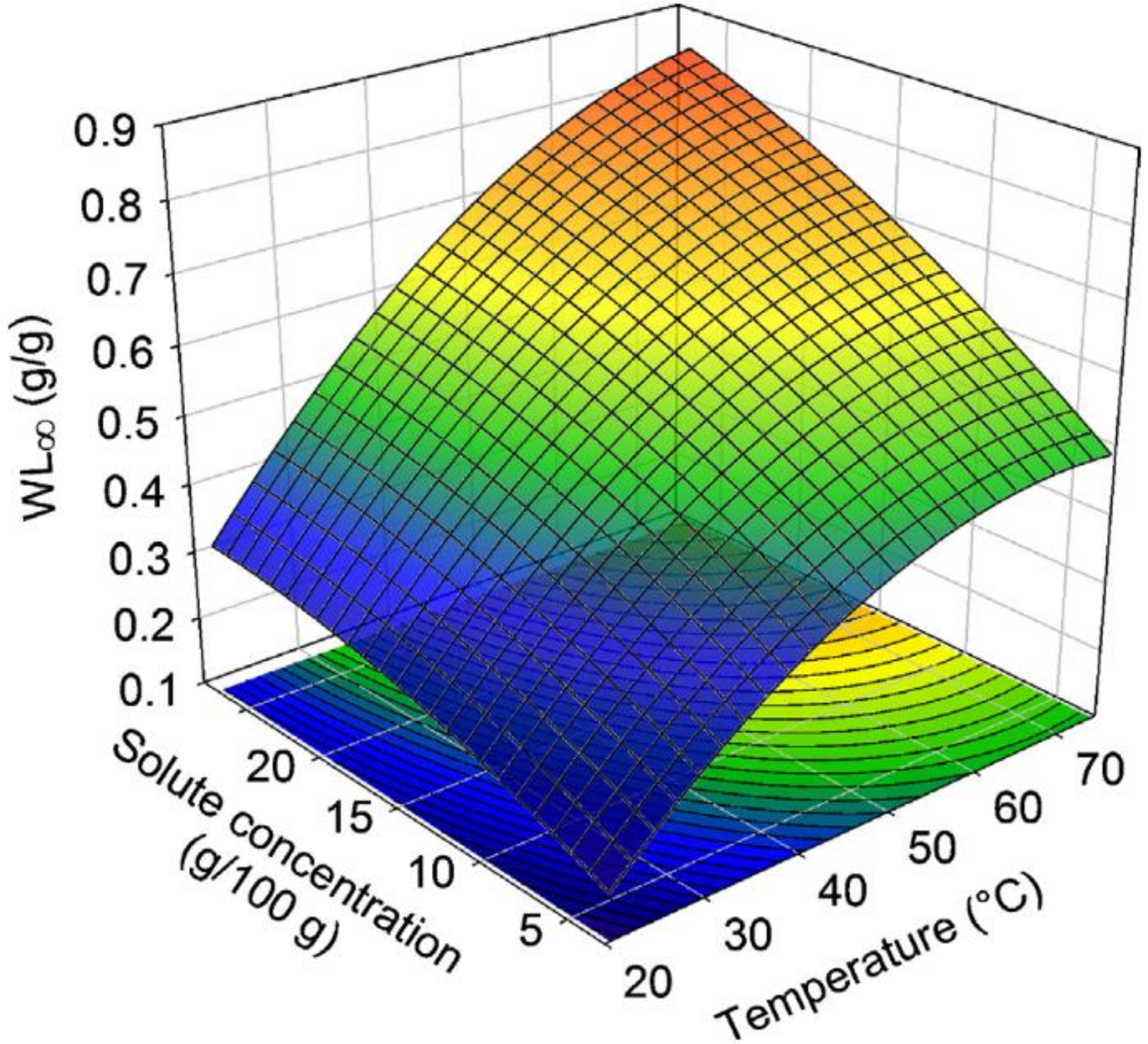


Figure 8. Effect of brine concentration and process temperature on estimated water loss at equilibrium during osmotic dehydration of radish slices in NaCl solutions.

(Herman-Lara et al., 2013)

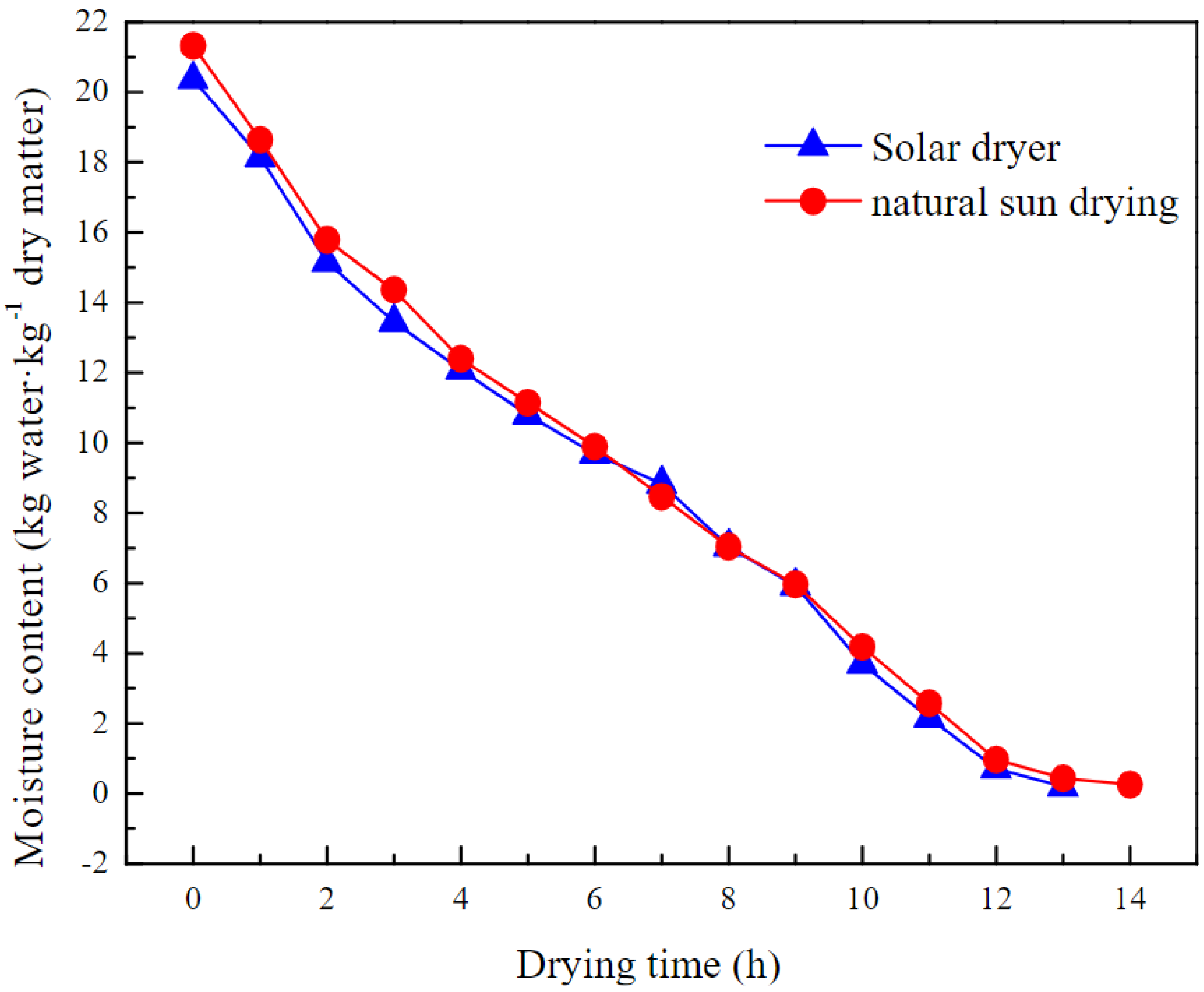


Figure 9. Moisture content variation obtained using the solar dryer and natural drying during drying periods.

(Kong et al., 2021)

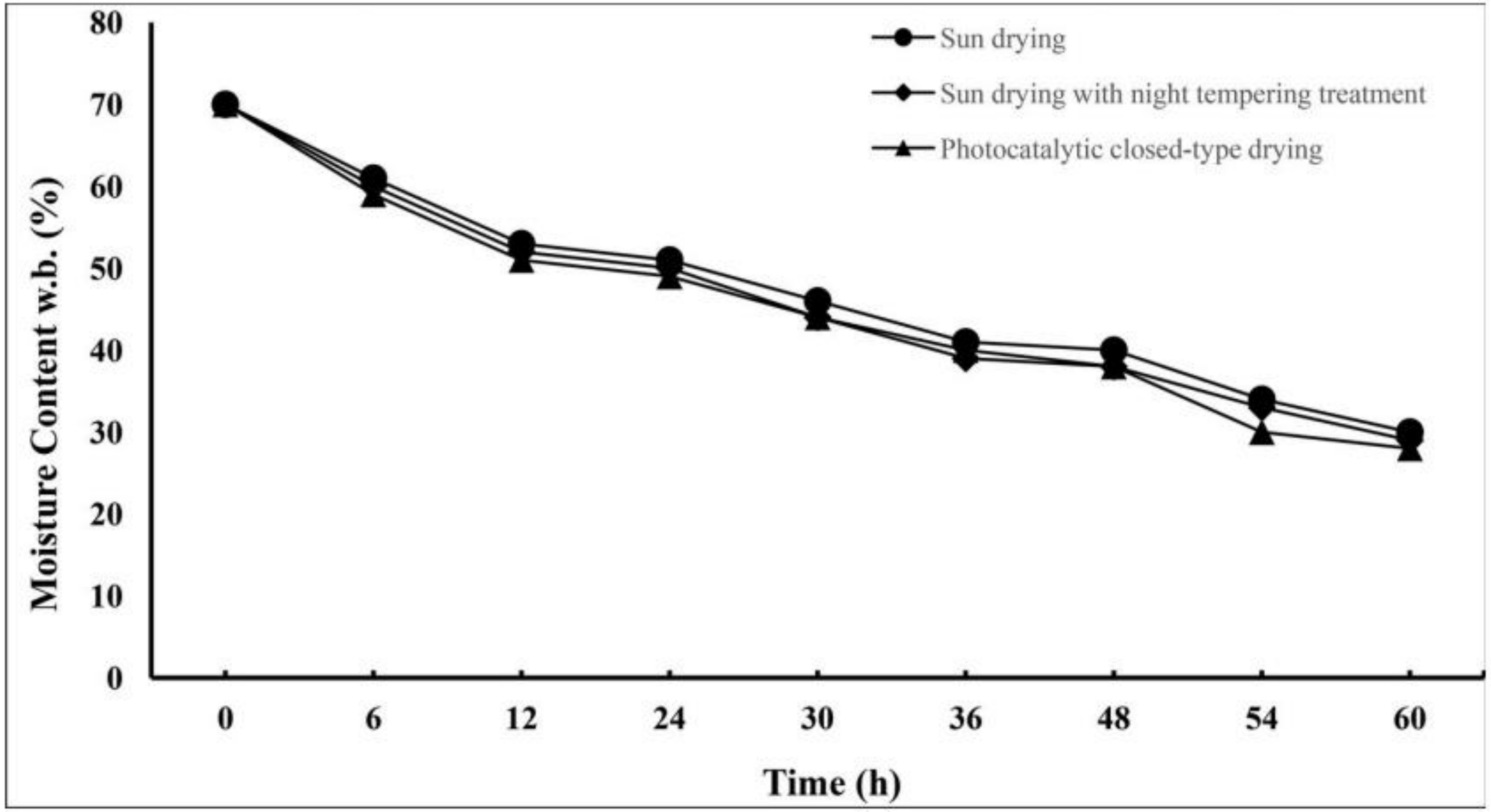
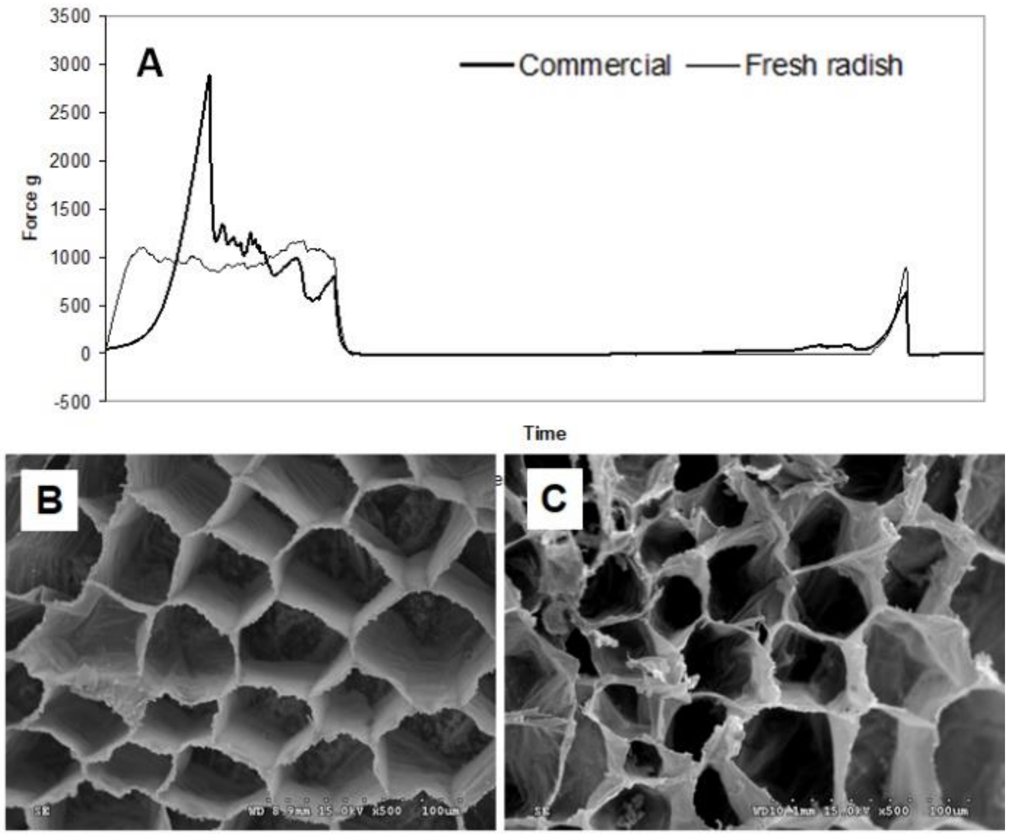


Figure 10. Representative drying curves for sun drying, sun drying with night tempering treatment, and photocatalytic closed-type drying respectively of brined ume.



- hardness (27.94%) due to its direct effect on the tissue hardening.
- fracturability (16.27%), crispiness (10.59%) crunchiness (2.67%).

Figure 11. The expected effects of the processing conditions on the quality parameters: an increasing of the peak force due to case hardening (from 1170.3 g to 2891.3 g). (A) Comparison of TPA curves (B) SEM photograph of a fresh radish sample (C) SEM photograph of sun-dried radish sample

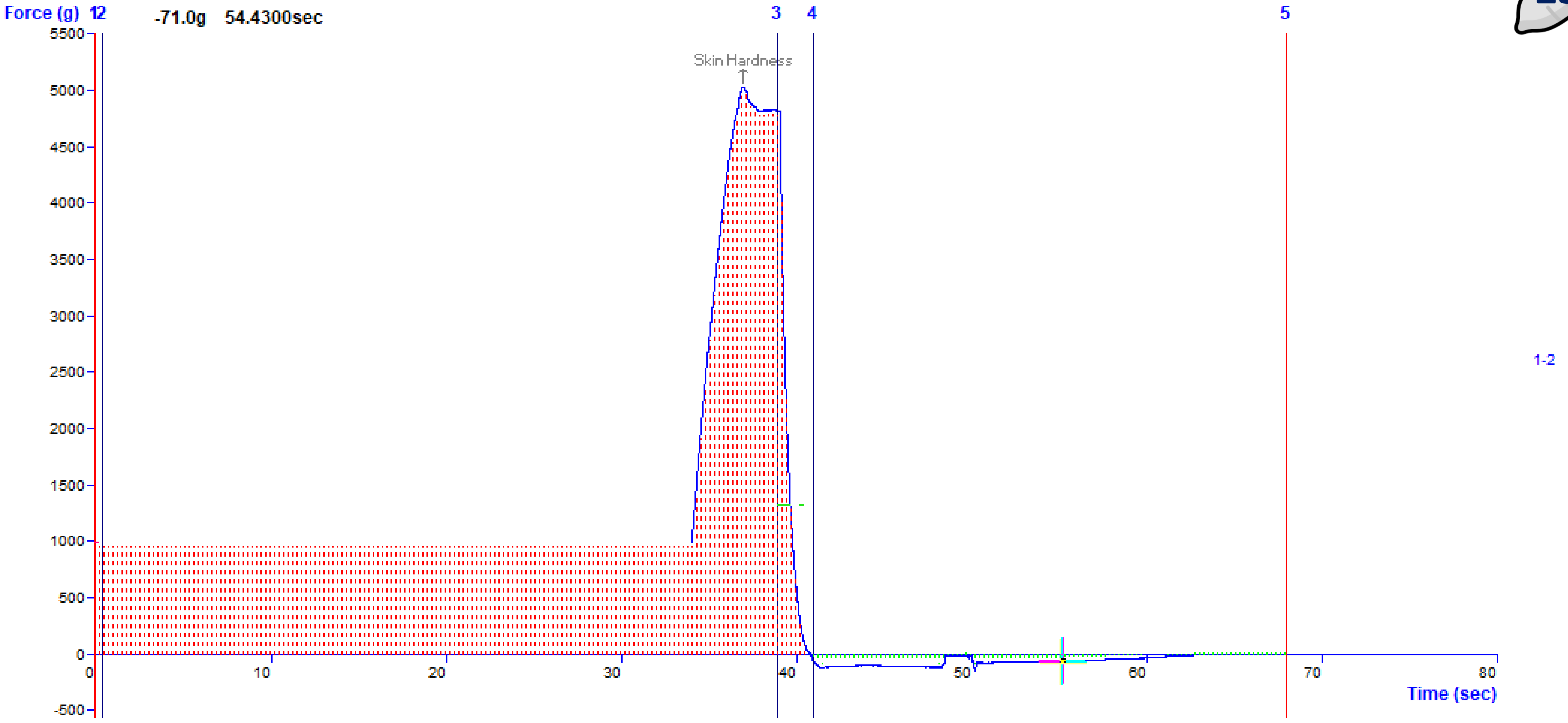


Figure 12. TPA analysis of fresh radish

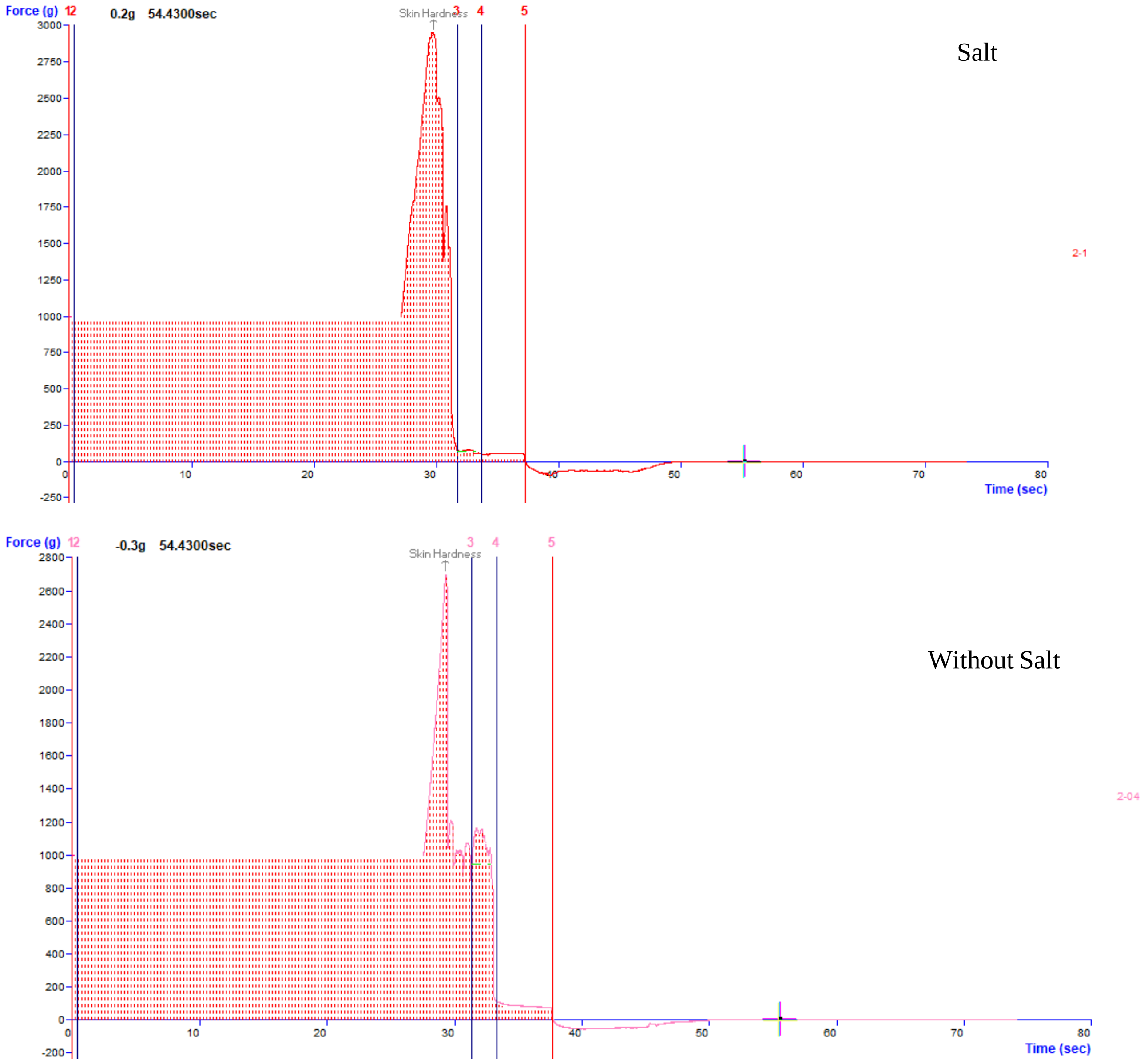


Figure 13. TPA analysis of Asian white radish treated by using Full spectrum sun light drying

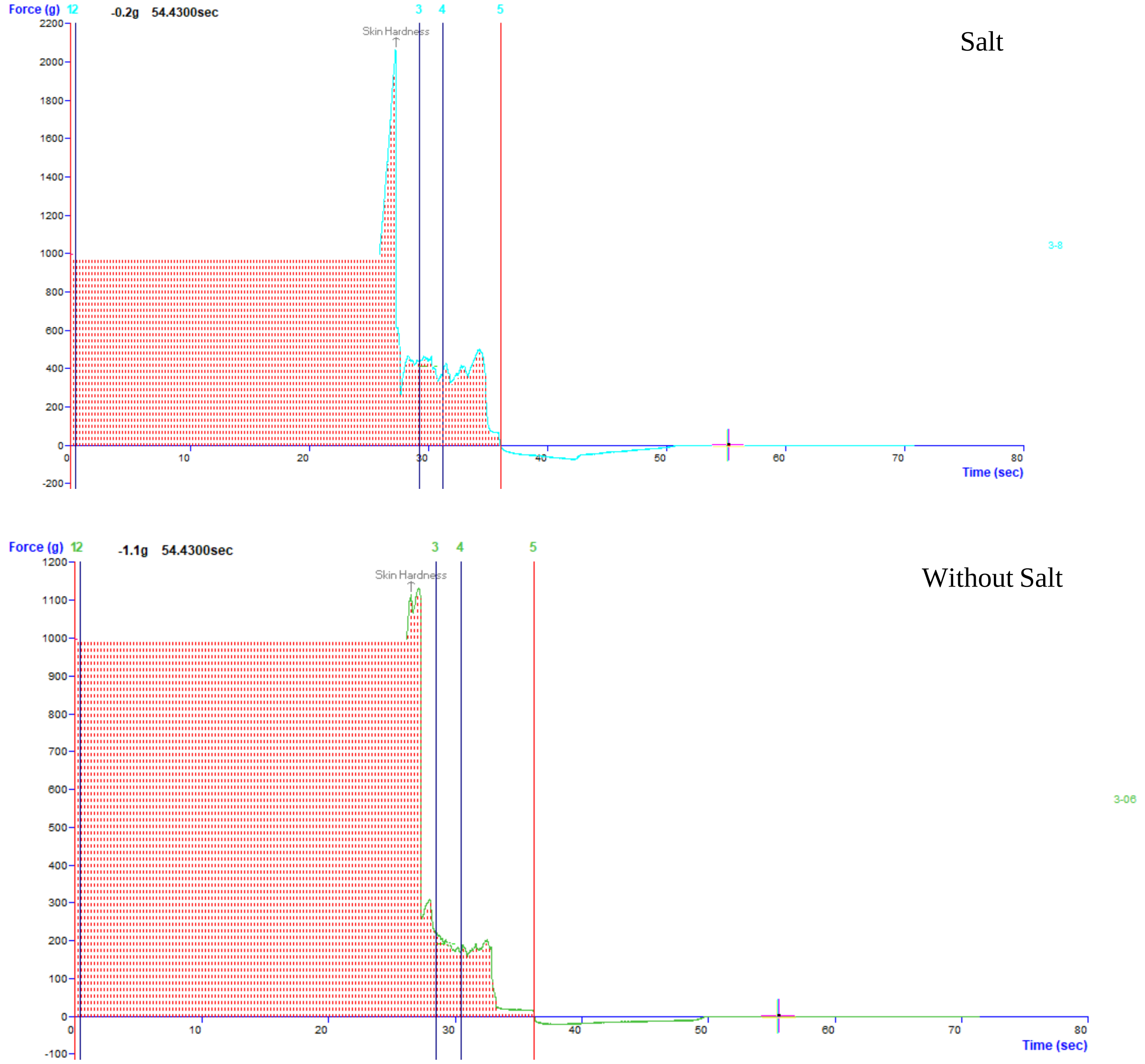
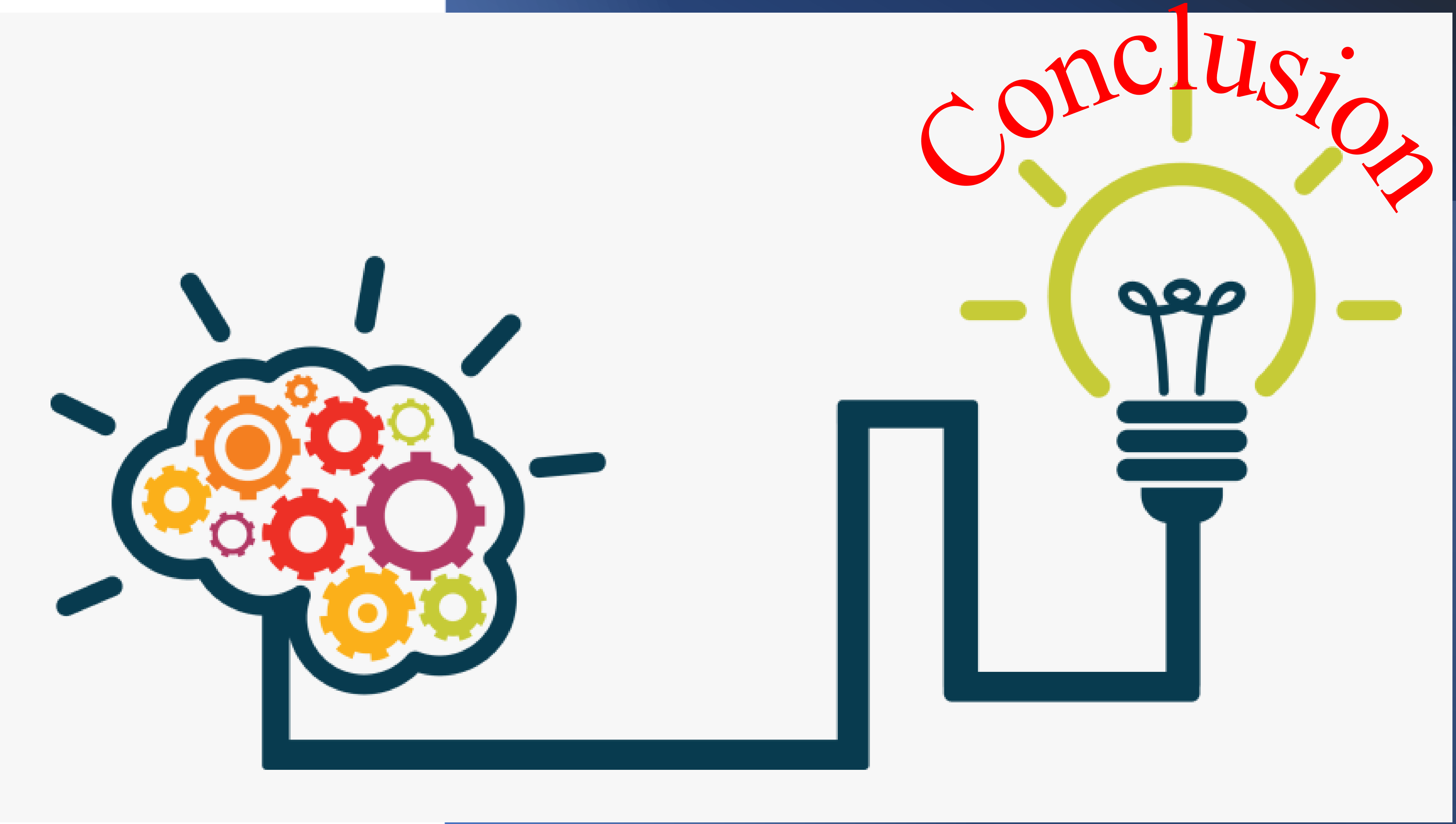


Figure 14. TPA analysis of Asian white radish treated by hot air-drying method


Conclusion

Conclusion

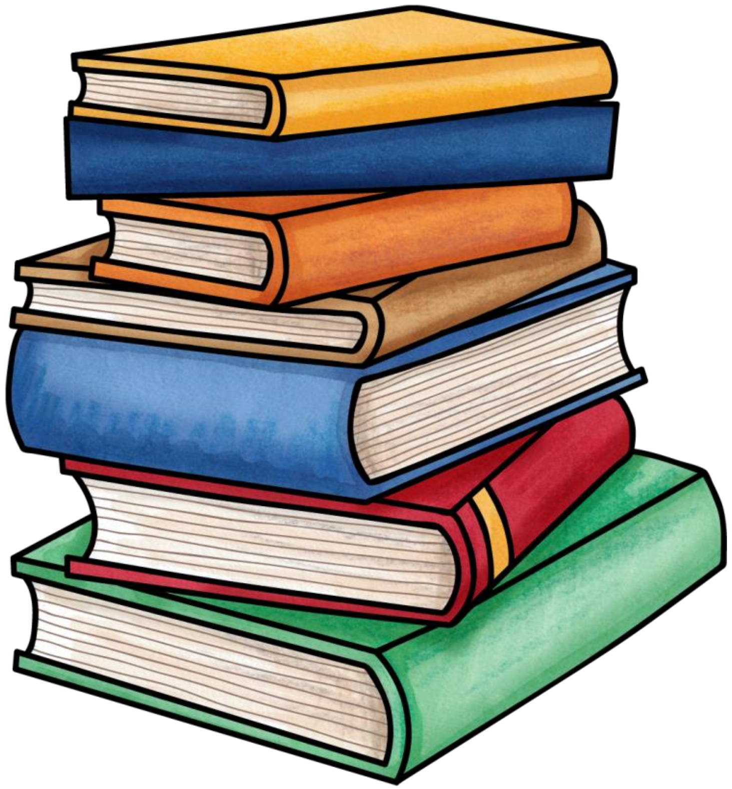
Color L* value significantly decreased and a* and b* values increased in both drying methods.

Moisture content and water activity (Aw) found decreased with time and temperature.

Artificial sun drying took less time to dry samples than sun drying. Faster drying done by this drying method.

Hii model were selected among different models to prove statistical analysis and prediction of drying characteristics.

References



- Coogan, R. C., & Wills, R. B. H. (2002). Effect of drying and salting on the flavour compound of Asian white radish. Food chemistry, 77(3), 305-307.
- Pandiselvam, R., Tak, Y., Olum, E., Sujayasree, O. J., Tekgül, Y., Çalışkan Koç, G., ... & Kumar, M. (2021). Advanced osmotic dehydration techniques combined with emerging drying methods for sustainable food production: Impact on bioactive components, texture, color, and sensory properties of food. Journal of Texture Studies.
- Herman-Lara, E., Martínez-Sánchez, C. E., Pacheco-Angulo, H., Carmona-García, R., Ruiz-Espinosa, H., & Ruiz-López, I. I. (2013). Mass transfer modeling of equilibrium and dynamic periods during osmotic dehydration of radish in NaCl solutions. Food and Bioproducts Processing, 91(3), 216-224.
- Kong, D., Wang, Y., Li, M., Liu, X., Huang, M., & Li, X. (2021). Analysis of drying kinetics, energy and microstructural properties of turnips using a solar drying system. Solar Energy, 230, 721-731.
- Gupta, P., & Premavalli, K. S. (2010). Effect of particle size reduction on physicochemical properties of ashgourd (Benincasa hispida) and radish (Raphanus sativus) fibres. *International Journal of Food Sciences and Nutrition*, *61*(1), 18-28.
- Lee, J. H., & Kim, H. J. (2009). Vacuum drying kinetics of Asian white radish (Raphanus sativus L.) slices. LWT-Food Science and Technology, 42(1), 180-186.
- Ma, F. Y., Huang, T. C., Nayi, P., & Chen, H. H. (2021). Combined effects of sunlight and tempering treatment on the oligomeric procyanidin formation in dried ume (Prunus mume Sieb. et Zucc.). *Drying Technology*, 1-12.
- Mugi, V. R., & Chandramohan, V. P. (2021). Shrinkage, effective diffusion coefficient, surface transfer coefficients and their factors during solar drying of food products–A review. *Solar Energy*, *229*, 84-101.
- Naing, Y. M., Khaing, T. T., & Hla, P. K. (2020) Study on drying characteristics and nutritional composition of white radish by solar cabinet dryers, tray dryer and open sun drying methods. *Journal of the Myanmar Academy of Arts and Science, XVIII. No.1C.*

Acknowledgement

THANK YOU

謝謝大家

You can find me at

pratiknayi97@gmail.com

+886 978394890

pratik890

https://scholar.google.com.tw/citations?user=FMGReewAAAAJ&hl=en&oi=ao

ORCID https://orcid.org/0000-0001-6667-2940

ELSEVIER Scopus 57216504886


Q & A