DRYING KINETICS AND CHANGES OF TOTAL PHENOLIC CONTENT, ANTIOXIDANT ACTIVITY AND COLOR PARAMETERS OF MANGO AND AVOCADO PULP IN REFRACTANCE WINDOW DRYING

Thi-Van-Linh Nguyen [1],* , Quoc-Duy Nguyen [1], Phuoc-Bao-Duy Nguyen [2,3]

[1] Faculty of Environmental and Food Engineering, Nguyen Tat Thanh University,Ho Chi Minh City, Vietnam

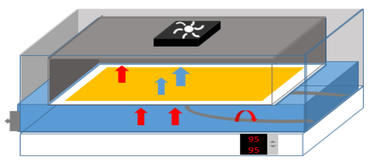
[2] Faculty of Electrical and Electronics Engineering, Ho Chi Minh University of Technology (HCMUT), Ho Chi Minh City, Vietnam

[3] Vietnam National University Ho Chi Minh City, Ho Chi Minh City, Vietnam

ABSTRACT

Refractance window drying is an innovative technology belonging to the fourth generation of drying technologies that could enhance the quality of the dried product and improve the drying process. In this study, two factors with the type of fruit pulps (avocado and mango) and drying temperature (ranging from 80 to 95 ºC) were investigated. Results showed that in refractance window drying, the evaporation process rapidly occurred, mainly in the falling-rate period with undetectable constant-rate period. The Weibull was the best fit model among eight investigated mathematical models that could determine the drying behavior. The effective diffusivity was found to be from 4.25×10^{-10} m^2/s to 7.24×10^{-10} m^2/s for avocado pulp, and from 4.50×10^{-10} m^2/s to 10.67×10^{-10} m^2/s for mango pulp when the drying temperature was changed from 80 to 95 ºC. Moreover, the corresponding activation energy was 32.06 and 66.03 kJ/mol for avocado and mango pulp moisture evaporation, respectively, and the highest quality of powders of both dried pulps was obtained after processing at 90 ° C. The refractance window drying revealed a high potential in the production of fruit powders from avocado and mango due to the high retention of more than 80% of total phenolic content (TPC) and antioxidant activity. TPC could be used as a useful criterion for the evaluation of the drying process in terms of dried product quality [5]

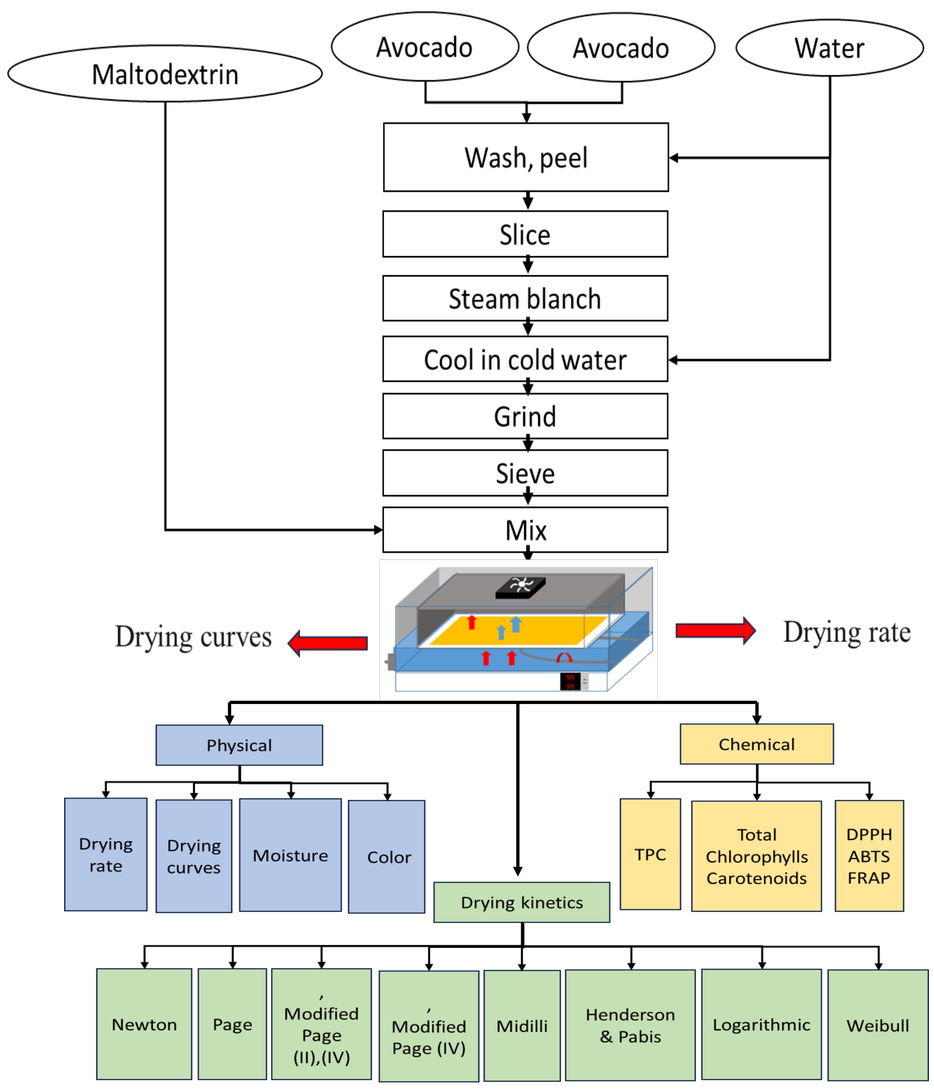
INTRODUCTION



- Nutrient Retention and Quality Preservation
- Reduce drying time
- Lower energy consumption
- High versatility

Picture 1: : Refractance Window

METHODS AND MATERIALS



CONCLUSIONS

This study aimed to determine the RW drying behavior of AP and MP. It was found that the drying process mainly occurred in the falling-rate period. Among the investigated mathematical models, the Weibull model showed the best- -predicted power of moisture ratio change during RW drying of AP and MP. The effective diffusivity and activation energy for moisture removal in RWdrying of AP and MP were in previously reported ranges of thin-layer drying of food. The RW drying had significant effects on the quality of dried avocado and mango and drying at 90 ° C could retain the highest quality of dried products. It was observed that the RW drying had a high potential in the production of fruit powder from avocado and mango due to the ability to retain more than 80% of TPC and antioxidant activity. This study found that TPC could be used as a useful criterion for evaluating drying process in terms of dried product quality because TPC was strongly correlated with the antioxidant activity and color parameters. [5]

RESULTS AND DISCUSSION

Quality of avocado and mango pulp

Table1. The physicochemical properties of avocado and mango pulp [5]

Properties		Avocado pulp	Mango pulp
Moisture (g/100 g fresh pulp)		82.4±0.5	90.03±0.68
Total phenolic content (mg GAE/g d.b.)		5.33±0.06	23.18±0.45
Antioxidant activity (mg TE/g d.b.)		1.60±0.05	6.31±0.66
Color parameters	L^*	61.05±1.02	66.63±0.52
	a^*	-23.77±1.17	3.41±0.94
	b^*	55.05±1.09	62.51±0.80

GAE – gallic acid equivalents; TE – Trolox equivalents; d.b. – dry basis

Drying curves and drying rate

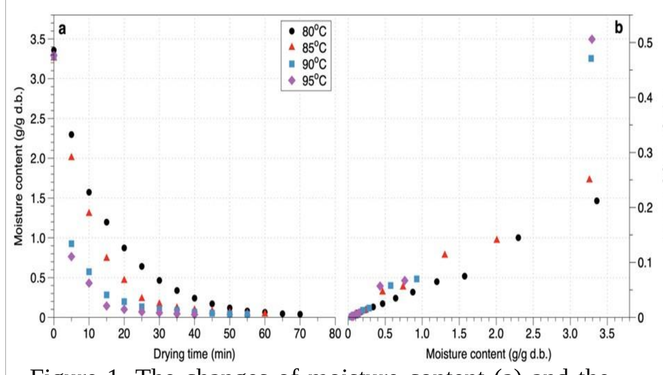


Figure 1. The changes of moisture content (a) and the drying rate curves (b) in refractance window drying of avocado pulp at different temperatures. [5]

Mathematical model for RW drying of AP and MP

Table 2. The effective diffusivity (Deff) and the activation energy (Ea) in refractance window drying of avocado pulp and mango pulp [5]

Material	Temperature (°C)	Deff (m2/s)	R2	E_a (kJ/mol)	R2
Avocado pulp	80	4.45×10^{-10}	0.9978	32.06	0.8363
	85	5.02×10^{-10}	0.9610		
	90	5.15×10^{-10}	0.9083		
	95	7.24×10^{-10}	0.9138		
Mango pulp	80	4.5×10^{-10}	0.9928	66.03	0.9678
	85	5.79×10^{-10}	0.9968		
	90	9.19×10^{-10}	0.9935		
	95	10.67×10^{-10}	0.9967		

R^2 – coefficient of determination

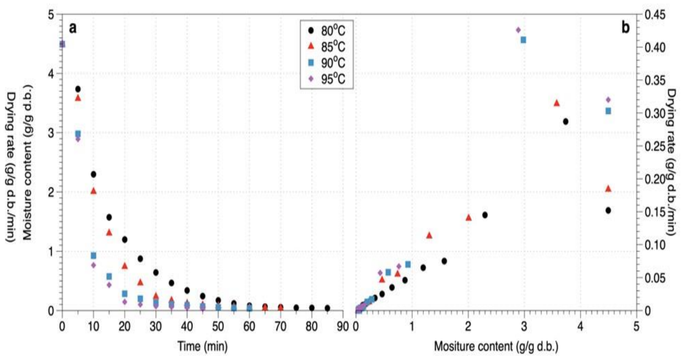


Figure 2. The changes of moisture content (a) and the drying rate curves (b) in refractance window drying of mango pulp at different temperatures. [5]

Changes of polyphenol content, antioxidant activity and color in RW drying of AP and MP

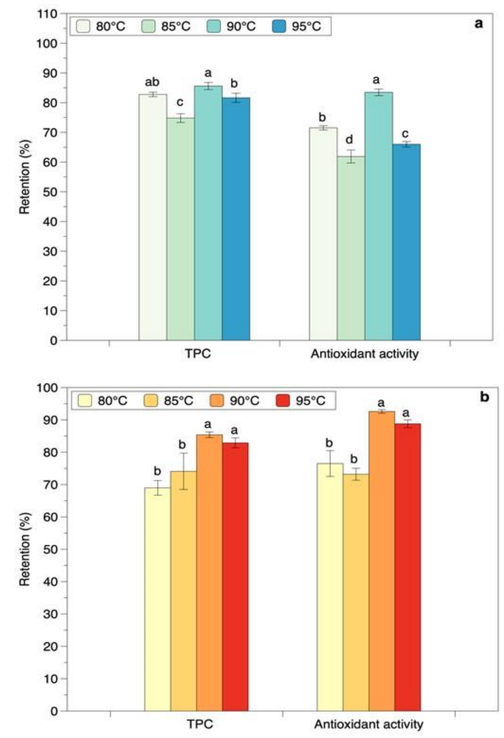


Figure 3.The total phenolic content (TPC) and antioxidant activity of powders of avocado pulp (a) and mango pulp (b) obtained by refractance window drying at different temperatures. The same letters above bars within a group indicated that the values are not significantly different (p≥0.05) [5]

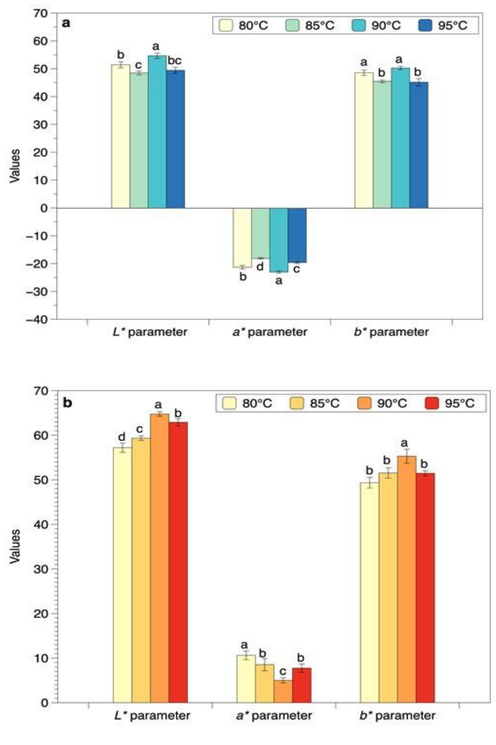


Figure 4. The color parameters of powders avocado pulp (a) and mango pulp (b) obtained by refractance window drying at different temperatures. The same letters above bars within a group indicated that the values are not significantly different (p≥0.05). [5]

Table 3. Coefficients of Pearson correlation between total phenolic content (TPC), antioxidant activity, and color parameters (L^*, a^*, and b^*) of avocado powders obtained by refractance window drying at different temperatures. [5]

	TPC	Antioxidant activity	L*	a*
Antioxidant activity	0.825 (0.001)	1		
L*	0.815 (0.001)	0.926 (0.000)	1	
a*	-0.893 (0.000)	-0.957 (0.000)	-0.889 (0.000)	1
b*	0.760 (0.004)	0.879 (0.000)	0.937 (0.000)	-0.867 (0.000)

The *p values* are shown in parentheses. Correlations are considered statistically significant at p<0.05 (in bold).

Table 4. Coefficients of Pearson correlation between total phenolic content (TPC), antioxidant activity, and color parameters (L^*, a^*, and b^*) of mango powders obtained by refractance window drying at different temperatures. [5]

	TPC	Antioxidant activity	L^*	a^*
Antioxidant activity	0.881 (0.000)	1		
L^*	0.905 (0.000)	0.888 (0.000)	1	
a^*	-0.748 (0.005)	-0.672 (0.017)	-0.883 (0.000)	1
b^*	0.514 (0.087)	0.529 (0.077)	0.705 (0.010)	-0.805 (0.002)

The *p values* are shown in parentheses. Correlations are considered statistically significant at p<0.05 (in bold).

Contact

Thi-Van-Linh Nguyen
Department of Food Technology, Institute of Applied Technology and Sustainable Development, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam
Website:
- https://ntt.edu.vn
- https://kttpmt.ntt.edu.vn
Phone: (+84) 19002039 - ext. 409
Email: ntvlinh@ntt.edu.vn

References

1. Nindo, C.I., Tang, J. (2007). Refractance window dehydration technology: A novel contact drying method. Drying Technology, 25(1), 37–48.
2. Abbasi, A.M., Guo, X., Fu, X., Zhou, L., Chen, Y., Zhu, Y., Yan, H., Liu, R.H. (2015). Comparative assessment of phenolic content and in vitro antioxidant capacity in the pulp and peel of mango cultivars. International Journal of Molecular Sciences, 16(6), 13507–13527.
3. Comerford, K.B., Ayoob, K.T., Murray, R.D., Atkinson, S.A. (2016). The role of avocados in complementary and transitional feeding. Nutrients, 8(5), art. no. 316.
4. Yao, L., Fan, L., Duan, Z. (2020). Effect of different pretreatments followed by hot-air and far-infrared drying on the bioactive compounds, physicochemical property and microstructure of mango slices. Food Chemistry, 305, art. no. 125477.
5. Nguyen, T. V. L., Nguyen, Q. D., & Nguyen, P. B. D. (2022). Drying kinetics and changes of total phenolic content, antioxidant activity and color parameters of mango and avocado pulp in refractance window drying. Polish Journal of Food and Nutrition Sciences, 72(1), 27-38.