

(2008) Corzo et al.

/ /

/ ×

(Rafiee,

/ ×

et al., 2009)

(2008) Aghbashlo et al.

/ ×

/ ×

(2005) Simal et al.

() / /

(Anon.,

2007)

(2007) Meisami asl

()

/ ×

/ ×

) ± / °C (LM35)

±% (

)

/ g

(A & D

GF3000

(2007) Rafiee et al.

.(Sharifi, 2005)

() TESTO 405-V1

()

()

-
- 1. Moisture Diffusion Coefficient
 - 2. Effective diffusivity
 - 3. Fick's First Law

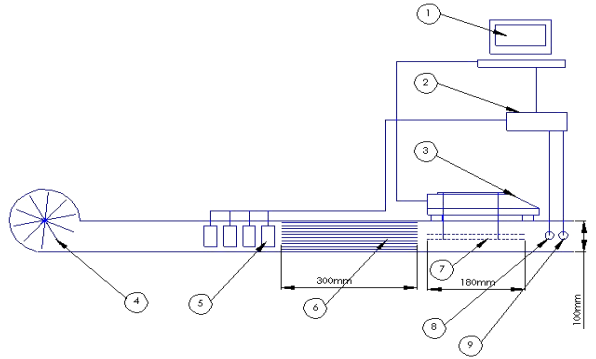
(Akpınar et al.,

$$MR = \frac{M - M_e}{M_0 - M_e}$$

M : MR
 M_0 : M

:2003)

()



()

(Gunhan et al., 2005)

()

$$MR = \frac{M}{M_0}$$

()

M : MR
 M_0 : M

(Doymaz, 2007a; Goyal

: M_0

et al, 2007; Menges & Ertekin, 2006;2006)

()

°C

(ASAE,2001)

$$M = \frac{W_w - W_d}{W_d}$$

()

M

W_w (d.b., kg/kg)

(kg) W_d (kg)

SPSS 16

(Khanchegardan, 2009)

$$MR = \exp(-kt^n)$$

()

n (l/min) k (min) t

(χ^2)

(R^2)

(RMSE)

χ^2

R^2

(Goyal et al.,

RMSE

(1/T) ln(D_{eff}) K :T_a .2007; Menges & Ertekin, 2006; Yaldiz; 2001)

$$\chi^2 = \frac{\sum_{i=1}^n (MR_{exp,i} - MR_{pre,i})^2}{N - n} \quad ()$$

$$RMSE = \left[\frac{1}{N} \sum_{i=1}^n (MR_{pre,i} - MR_{exp,i})^2 \right]^{1/2} \quad ()$$

()

()

$$M_{exp,i} \quad M_{pre,i}$$

()

(Akpınar et al., 2003;

.Togrul & Pehlivan, 2003)

(Doymaz, 2006)

()

:(Rafiee et al., 2009)

$$\frac{\partial M}{\partial t} = \nabla [D_{eff} (\nabla M)] \quad ()$$

$$MR = \frac{M}{M_0} = \frac{8}{\pi^2} \sum_{n=1}^{\infty} \frac{1}{(2n-1)^2} \exp\left(-\frac{(2n-1)^2 \pi^2 D_{eff} t}{4L^2}\right)$$

(m²/s)

:D_{eff}

(kg water/kg dry solid)

:M

:MR

(s) :t

(m)

:L

D_{eff}

:n

()

()

$$MR = \frac{8}{\pi^2} \exp\left(-\frac{\pi^2 D_{eff} t}{4L^2}\right) \quad ()$$

ln(MR)

k₀

()

:(Rafiee et al., 2007) ()

()

:(Doymaz, 2006)

$$k_0 = \frac{\pi^2 D_{eff}}{4L^2} \quad ()$$

$$D_{eff} = D_0 \exp\left(-\frac{E_a}{RT_a}\right) \quad ()$$

/ /

m²/s

:D₀

kJ/mol

:E_a

kJ/mol K

:R

()

(Giner & Mascheroni, 2002)

()

MR

(

()

(.

χ^2	RMSE	R^2 (mm)
/	/	/
/	/	/

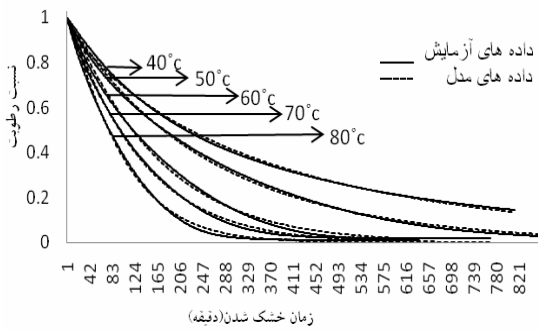
(2010) Rafiee et al. .

/ × / ×

(2006) Garau et al. .

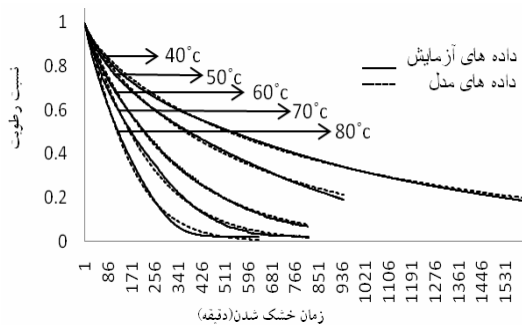
R^2	k	n	(°C)
/	/	/	
/	/	/	
/	/	/	
/	/	/	
/	/	/	

/ × / ×



R^2	k	n	(°C)
/	/	/	
/	/	/	
/	/	/	
/	/	/	
/	/	/	

() ()



()

()

D_{eff}

()

/ × / ×

$^{\circ}\text{C}$		T
K		T_{abs}
		χ^2
m^2/s		D_{eff}
m^2/s		D_0
kJ/mol		E_a
kJ/mol K		R
K		T_a

		MR
		N
		n
		RMSE
		s
kg		W_d
kg		W_w
		χ^2

REFERENCES

- thin layer drying kinetics of plum in a tunnel dryer. *Journal of Food Engineering*, 79, 176–180.
- Gunhan, T., Demir, V., Hancioglu, E., & Hepbasli, A. (2005). Mathematical modelling of drying of bay leaves. *Energy Conversion and Management*, 46, 1667–1679.
- Khanchehgardan, M.R. (2009). *Drying Kinetics Modeling of Sweet Lemon Slice*. M. Sc. thesis. Department of Food Science & Technology, Gorgan University of Agricultural Sciences & Natural Resources, Gorgan, Iran. p. 100. (In Farsi)
- Meisami asl, E. (2007). *Mathematical modeling of apple (Golab variety) slices*. M. Sc. thesis. Department of Agricultural Machinery Engineering, University of Tehran, Karaj, Iran. (In Farsi)
- Menges, H.O., & Ertekin, C. (2006). Mathematical modeling of thin layer drying of Golden apples. *Journal of Food Engineering*, 77, 119–125.
- Midilli, A., Kucuk, H., & Yapar, Z. (2002). A new model for single-layer drying. *Drying Technology*, 20 (7), 1503–1513.
- Rafiee, S., Kashaninejad, M., Keyhani, A., and Jafari, A. (2009). Pistachio Nut (Ohadi) Mass Transfer Simulation during Drying with High Temperature Finite Element Method. *Journal of Agricultural Science & Technology*, 11, 137-146.
- Rafiee, S., Jafari, A., Kashaninejad, M., & Omid, M. (2007). Experimental & Numerical Investigations of Moisture Diffusion in Pistachio Nuts during Drying with High Temperature & Low Relative Humidity. *International Journal of Agriculture & Biology*, 9 (3), 412-415.
- Rafiee, S., Sharifi, H., Keyhani, A., & Jafari, A. (2007). Modeling Effective Moisture Diffusivity of Orange ('Thompson'). The 5th Asia-Pacific Drying Conference (ADC07). 1215-1221.
- Rafiee, S., Sharifi, M., Keyhani, A., Omid, M., Jafari, A., Mohtasebi, S.S., & Mobli, H. (2010). Modeling Effective Moisture Diffusivity of Orange Slice (Thompson cv.), *International Journal of Food Properties*, 13(1), 32 – 40.
- Simal, S., Femenia, A., Garau, M.C., & Rossello, C. (2005). Use of exponential, Page's & diffusional models to simulate the drying kinetics of kiwi fruit. *Journal of Food Engineering*, 66, 323–328.
- Simal, S., Mulet, A., Tarrazo, J. and Rossello, C. (1996). Drying models for green peas. *Food Chemistry*, 55 (2), 121–128.
- Aghbashlo, M., Kianmehr, M. H. & Samimi Akhijahani, H. (2008). Influence of drying conditions on the effective moisture diffusivity, energy of activation & energy consumption during the thin-layer drying of berberies fruit (berberidaceae). *Energy Conversion and Management*, 49, 2865-2871.
- Akpinar, E., Bicar, Y., & Yildiz, C. (2003). Thin layer drying of red pepper. *Journal of Food Engineering*, 59, 99-104.
- Anonymous. (2007). Available at <http://en.wikipedia.org/WIKI/kiwi-fruit>.
- Anonymous. (1998). *Five garden products*. Statistics & Information Organization. Ministry of Agriculture. (In Farsi)
- Anonymous. (2005). *Five garden products*. Statistics & Information Organization. Ministry of Agriculture. (In Farsi)
- Anonymous. (2006). Citrus Research Institute of Iran. Ministry of Agriculture.
- Anonymous., (2010). *The results of a sample survey designs garden products in 1387*. Statistics Bureau, Ministry of Agriculture, 15. (In Farsi)
- ASAE standards. (2001). Thin layer drying of grains & crops. *ASAE S448 DEC93*.
- Corzo, O., Bracho, N. & Alvarez, C. (2008). Water effective diffusion coefficient of mango slices at different maturity stages during air drying. *Journal of Food Engineering*, 87, 479-484.
- Crank J., (1975). *The mathematics of diffusion*. 2nd ed. Oxford University Press, Oxford, 104-106.
- Doymaz, I. (2006). Thin-layer drying behaviour of mint leaves. *Journal of Food Engineering*, 74, 370–375.
- Doymaz, I. (2007a). Influence of pretreatment solution on the drying of sour cherry. *Journal of Food Engineering*, 78, 591–596.
- Doymaz, I. (2007b). Air-drying characteristics of tomatoes. *Journal of Food Engineering*, 78, 1291–1297.
- Garau, M.C., Simal, S., Femenia, A., & Rossello, C. (2006). Drying of orange skin: drying kinetics modeling & functional properties. *Journal of Food Engineering*, 75, 288–295.
- Giner, S. A. & Mascheroni, R. H. (2002). Diffusive drying kinetics in wheat. Part 2. Applying the simplified analytical solution to experimental data. *Biosystems Engineering*, 81(1), 85–97.
- Goyal, R.K., Kingsly, A.R.P., Manikantan, M.R., & Ilyas, S.M. (2007). Mathematical modelling of

Department of Agricultural Machinery Engineering, University of Tehran, Karaj, Iran.

Yaldiz, O. (2001). Effect of drying properties on drying characteristics of carrot & leek. In: Proceedings of the 20th *National Congress on Agricultural Mechanization*, Sanliurfa, Turkey.

Togrul, I. T., & Pehlivan, D. (2003). Modeling of drying kinetics of single apricot. *Journal of Food Engineering*, 58(1), 23–32.

Sharifi, M. (2007). *Investigation of drying models & comparison of time & consumptions of orange (Thompson variety) slice*. M. Sc. thesis.

Archive of SID