MODELING DRYING KINETICS OF DOMINGA GRAPES

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OBJECTIVES

Influence of air temperature and velocity on drying kinetics of grapes.

Mathematical modeling of drying kinetics.

INTRODUCTION

• Several authors studied the effects of different drying conditions.

• Some common models used to fit experimental data are:

A) The Exponential model (Newman et al., 1996):

$$\frac{M-Me}{Mo-Me}=\exp(-Kt)$$

B) Two simplified forms of Fick's diffusion equation:

$$\frac{M-Me}{Mo-Me}=\frac{6}{\pi^2}\exp(\frac{-\pi^2 Dt}{r^2}) \qquad \frac{M}{Mo}=\frac{6}{\pi^2}\exp(\frac{-\pi^2 Dt}{r^2})$$

C) The two-compartment diffusion model developed by Glenn (Madamba et al., 1996):

$$\frac{M-Me}{Mo-Me}=A_o\exp(-k_o t)+A_1\exp(-k_1 t)$$

MATERIALS & METHODS

• Dominga grapes

blanched in water at 100ºC during 30s

• On-line acquisition: total weight; air temperature; air relative humidity

• Measurement: Air velocity; Initial water content

RESULTS & DISCUSSION

• A single falling-rate behavior was observed.

• Air velocity in the tested range, has no significant effect. ⟷ internal diffusion

• The air temperature effect follows the Arrhenius law: $K = Ko\exp\left[-\frac{Ea}{R}(\frac{1}{T}-\frac{1}{To})\right]$

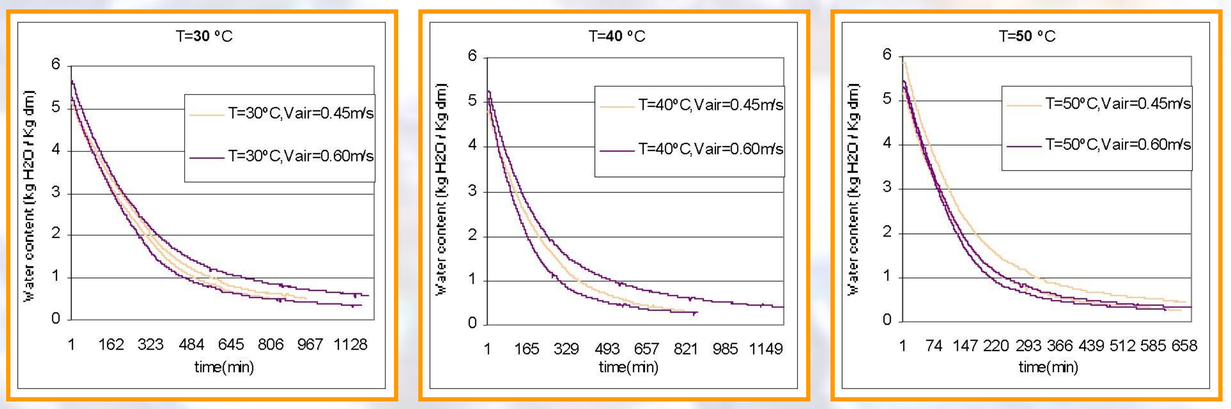

Fig. 1 - Effect of air velocity on drying kinetics of Dominga grapes (experimental data).

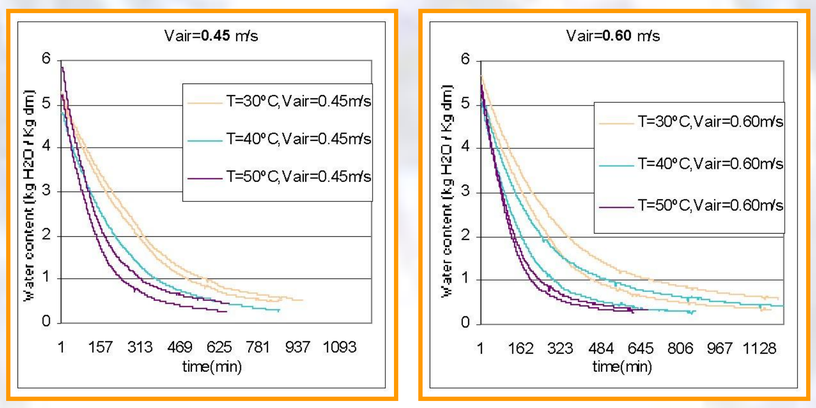

Fig. 2 - Effect of air temperature on drying kinetics of Dominga grapes (experimental data).

Tab. 1 - Model parameters and corresponding experiments.

Experiment no.	*T (ºC)*	*V_{air} (m/s)*	*K (min^{-1})*	*Me (kg/kg dm)*	r^2
1	30	0.45	0.0006563	0.0939	0.9993
2	50	0.45	0.001413	0.4201	0.9995
3	40	0.45	0.0008827	0.1736	0.9997
4	30	0.45	0.0006237	0.1762	0.9992
5	50	0.45	0.001479	0.2226	0.9987
6	30	0.60	0.000778	0.2613	0.9984
7	50	0.60	0.001663	0.2174	0.9968
8	40	0.60	0.001227	0.2613	0.9993
9	50	0.60	0.001573	0.2970	0.9985
10	30	0.60	0.0007049	0.5398	0.9999
11	40	0.60	0.0008954	0.4690	0.9994

• A one-step non-linear regression (Arabshahi and Lund), was performed simultaneously to all the data:

Activation Energy = 31.8 ± 0.3 kJ/mol
Mean equilibrium moisture content = 0.338±0.007 kg water/kg dry mater

LITERATURE:

Arabshahi, A. and Lund, D. B., 1985, Considerations in calculating kinetic parameters from experimental data, Journal of Food Process Engineering, (7), 4, pp. 239-251.
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Newman, G. M., Price, W. E. and Woolf, L. A., 1996, Factors influencing the drying of prunes. 1. Effects of temperature upon the kinetics of moisture loss during drying, Food Chemistry, (57), 2, pp. 241-244.

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