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Experimental and theoretical analysis of drying grapes under an indirect solar dryer and in open sun

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Abstract

In the present work, the drying behavior of grapes under open sun and into indirect solar dryer was studied. The indirect solar dryer was designed in the Solar Energy and Environment Laboratory of Mohammed V University, Rabat, Morocco. It consists of a solar collector, a heat exchanger, a water storage tank and a drying chamber. Results show that during off sunshine hours, the heat transfer from the water storage tank kept the grapes temperature higher than ambient temperature. Drying results indicated that the times required for drying grapes starting at the initial moisture contents of 79.8 % (w.b.) till final moisture contents of 20.2 % (w.b.) were 120 h and 201 h in indirect solar and open sun drying, respectively. The drying data were fitted to 10 thin-layer drying models to describe and compare the drying characteristics of the grapes. Comparisons were based on the coefficient of correlation (R), root mean square error (RMSE) and reduced chi-square (χ^2). Midilli et al. model is found to best depict grapes drying behavior in both indirect solar and open sun drying. The evaluated values of the effective moisture diffusivity of grapes sun drying and grapes indirect solar drying when applying the Fick's diffusion model were 2.34×10^{-11} and 4.08×10^{-11} m²/s, respectively.

Keywords: Indirect solar dryer, Open sun drying, Grapes, Storage system, Effective moisture diffusivity

Nomenclature

A, b, c	Empirical constants in drying models
D_{eff}	Effective diffusivity (m ² /s)
k, k ₀ , k ₁	Empirical constants in drying models
K	Slope
MR _(exp,i)	Experimental moisture ratio
MR _(pre,i)	Predicted moisture ratio
M	Moisture content at time t (kg water/kg dry matter)
M _e	Equilibrium moisture content (kg water/kg dry matter)
M ₀	Initial moisture content (kg water/kg dry matter)
R	Coefficient of correlation
RMSE	Root mean square error
χ^2	Reduced chi-square
t	Drying time (h)
r	Radius (m)
TST	True solar time

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