Title The fitting of various models to water sorption isotherms of tea stored in a chamber under controlled temperature and humidity

Author Nurhan Arslan and Hasan Togˇrul

Citation Journal of Stored Products Research Volume 42, Issue 2, 2006, Pages 112-135

Keyword Tea; Moisture sorption; Isotherms; Thermodynamic; Atomizing humidification system

Abstract

The moisture sorption characteristics of tea stored in a chamber regulated by an atomizing humidification system were investigated at 25, 35 and 45 °C for water activity ranging from 0.1 to 0.9. The sorption isotherms of tea were typical type II sigmoidal curves according to BET classification. In both adsorption and desorption, an increase in temperature resulted in lower equilibrium moisture contents at corresponding values of water activity. The sorption isotherms exhibited hysteresis over the whole water activity range. GAB, BET, Henderson, Iglesias and Chirife, Oswin, Peleg, Smith and Caurie models were applied for analysing the experimental data. Nonlinear regression analysis was used for the determination of the parameters in the equations. Estimated parameters and fitting ability for sorption models were evaluated. The Peleg model was found to be the most suitable for describing the relationship between equilibrium moisture content and water activity for the whole range of temperatures and relative humidities studied. The surface area of monolayer was calculated. The BET equation was solved for the monolayer moisture content and the corresponding a_w values at which monolayer forms were presented. Sorption isotherm data were used to determine the thermodynamic functions such as isosteric heat of sorption, sorption entropy, spreading pressure, net integral enthalpy and entropy. The Clausius–Clapeyron equation was used to evaluate the isosteric heats of sorption. The isosteric heats of sorption and sorption entropy decreased with increasing moisture content. The heat of desorption was little higher than that of adsorption at low moisture content. The enthalpy–entropy compensation theory could be successfully applied to water sorption by tea. This theory showed that the moisture sorption of tea was governed by enthalpy-controlled mechanisms. The spreading pressure increased with increase in water activity and decreased with increasing temperature. The net integral enthalpy decreased with moisture content while the net integral entropy increased.