APPLICATION OF NEURAL NETWORK FOR ESTIMATION OF PISTACHIO POWDER SORPTION ISOTHERMS

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Abstract—Moisture sorption isotherms for pistachio powder were determined by gravimetric method at temperatures of 15, 25, 35 and 40°C. Some mathematical models were tested to measure the amount of fitness of experimental data. The mathematical analysis proved that Caurie model was the most appropriate one. As well, adsorption-desorption moisture content of pistachio powder were predicted using artificial neural network (ANN) approach. The results showed that, MLP network was able to predict adsorption-desorption moisture content with R² values of 0.998 and 0.992, respectively. Comparison of ANN results with classical sorption isotherm models revealed that ANN modeling had greater accuracy in predicting equilibrium moisture content of pistachio powder.

Keywords—Pistachio, Modeling, Sorption isotherm, Neural network approach, Isosteric heat of sorption.

I. INTRODUCTION

The pistachio (Pistacia vera L.) is cultivated in the Middle East, United States, and Mediterranean countries (Tavakolipour and Mokhtarian, 2012). Pistachio is one of the most important Iranian horticultural products with high export value for the country and Persian cultivars have different taste and flavour. According to Food and Agricultural Organization (FAO), Pistachio production in 2010 was reported 446647 MT, which Iran is dedicated of about 47.3% of the global production of pistachio in this year (FAO, 2010). According to position of this product in the country economy, suitable preservation and storage conditions is necessary to prevent spoilage.

During various postharvest processes such as drying, storage and packaging, water adsorption and desorption processes play an important role on deteriorative reactions (DRs) such as browning, lipid oxidation and microbial growth of pistachio nuts. The influence of moisture on DR has been explained in terms of αw, and this approach is now well established in controlling reaction and predicting food stability. Because αw is the most important parameter for the stability of raw and processed agricultural products, the sorption isotherms can be used to obtain their optimum residual moisture content and end point of a drying process, which is useful to design their suitable packaging systems and storage conditions, and to select proper ingredients for preparing a formulated intermediate moisture food (Tavakolipour and Kalbasi Ashtari, 2008).

Maskan and Karatas (1997) determined the sorption characteristics of whole pistachio nuts at 10, 20 and 30°C, and evaluated their data for fitting to some sorption equations. They found some important parameters such as monolayer moisture content and heat effects on water sorption. Additionally, the adsorption studies were done on few pistachio varieties and their products, e.g., raw pistachio (Pistacia terebinthus L.) and its protein isolate by Ayrancy and Dulbic (1992), pistachio nut paste at different T values (Hayoglu and Gamli, 2007). However, very limited data are available on sorption isotherms and other characteristics of different Persian pistachio varieties.

Presently, neural networks enact an important key as a powerful analysis machine in predicting the process parameters. The scientists were used ANN in various field of food processing. For example, using an ANN approach as intelligent tools for prediction of food drying parameters (Tavakolipour and Mokhtarian, 2012), freezing and thawing times (Goñi et al., 2008), osmotic dehydration parameters such as solid gain (SG) and water loss (WL) (Lertworasirikul and Saetan, 2010), anthocyanin concentration (Fernandes et al., 2011), antioxidiant activity (Cimpoi et al., 2011) and equilibrium moisture content (Amiri Chayjan and Esna-Ashari, 2010).

The aim of this study were: (1) evaluation of feasibility of neural network to predict adsorption and desorption moisture content of pistachio powder in order to momentarily monitor the storage conditions, (2) to determine the sorption isotherms and hysteresis effects and (3) to evaluate the suitability of various mathematical models for fitting the isotherms and determine the isosteric heat of sorption.

II. MATERIALS AND METHODS

A. Materials

Raw and dried Kerman variety pistachios were purchased from a local market. They were sorted and separated to split and nonsplit samples. Medium-sized and split pistachio nuts with a moisture content of 4.5% (d.b.) were selected for the tests. After harvesting, the pistachio nuts should be dried from a moisture content of about 40% to safe storage moisture of less than 7% wet basis (w.b.). Pistachio nuts dried to a range of 4–6% (w.b.) are graded higher in organoleptic quality indicators such as crispness and sweetness, and lower in bitterness and rancidity than those dried in the range of 6–11% (w.b.) moisture content. Pistachio powder was produced by weighing 10 g of pistachio kernels crushed in a home mill (Black and Decker, London, U.K.) for 30 s until its average particle size reached 250 microns. Various saturated salt solutions including LiCl, CH₂COOK, MgCl₂, K₂CO₃, Mg(NO₃)₂, NaNO₂, NaCl...