

ORIGINAL ARTICLE

Comparison between artificial neural networks and mathematical models for moisture ratio estimation in two varieties of green malt

Narjes Aghajani¹, Mahdi Kashaninejad², Amir Ahmad Dehghani³ & Amir Daraei Garmakhany¹¹ Department of Food Science & Technology, Azadshahr Branch, Islamic Azad University, Azadshahr, Golestan, Iran² Department of Food Science and Technology, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran³ Department of Water Engineering, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran**Keywords**

artificial neural networks; green barley malt; moisture ratio; thin&hyphen;layer drying.

Correspondence:

Amir Daraei Garmakhany, Department of Food Science & Technology, Azadshahr Branch, Islamic Azad University, Azadshahr, Golestan, Iran. Tel: +98 9183593298; Fax: +981714426432; Email: amirdaraey@yahoo.com

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Abstract

Introduction Artificial neural network (ANN) is a technique with flexible mathematical structure, which is capable of identifying complex non-linear relationship between input and output data. **Objectives** The aim of this study was a comparison between ANNs and mathematical models for moisture ratio estimation in two varieties of green malt. **Methods** In this study, drying characteristics of two varieties green malt Sahra and Dasht were studied at different temperatures (40, 55, 70 and 85 °C) by measuring the decrease in the mass of green malt with respect to time. A feed forward back propagation (FFBP) neural network was used to estimate the moisture ratio of green malt during drying. ANN was used to model green malt drying at different temperatures and a comparison was also made with the results obtained from Page's model. The variety, drying temperature and time were used as input parameters and the moisture ratio was used as output parameter. **Results** The results were compared with experimental data and it was found that the estimated moisture ratio by FFBP neural network is more accurate than Page's model. It was also found that moisture ratio decreased with increasing of drying time and temperature. **Conclusion** The ANN model was more suitable than other models for moisture ratio estimation in green malt.

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Introduction

Drying is the most common food preservation method used in practice (Yaldyz & Ertekyn, 2001; Midilli *et al.*, 2002; Janjai & Tung, 2005) and drying (kilning) of green malt with aim of arrest modification and render malt stable for storage, ensure survival of enzymes for mashing and introduce desirable flavour and colour characteristics and eliminate undesirable flavours have been done (Bamforth, 2005).

The moisture content of green malt is about 42–48% and usually an air temperature ranging from 30 °C to 85 °C or a constant temperature of air may be used to kilning of green

malt. High energy cost and the all year round nature of the malting process have led to number of developments in energy conservation. However, the effectiveness of those depends greatly on a theoretical knowledge of the drying process. But a little information about simulation of green malt drying is available.

Artificial neural networks (ANN) is a mathematical tool, which tries to represent low-level intelligence in natural organisms and it is a flexible structure, capable of making a non-linear mapping between input and output spaces (Rumelhart *et al.*, 1986). Artificial neural networks have already been applied to simulate processes such as