International Journal of Natural and Engineering Sciences 6 (3) : 11-14, 2012
ISSN: 1307-1149, E-ISSN: 2146-0086, www.nobel.gen.tr

Prediction of Moisture Content for Papaya Fruit During The Drying Process Using Artificial Neural Networks Technique

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Received : February 08, 2012
Accepted : March 16, 2012

Abstract

Non-destructive method for characterization of various crops during the harvesting process, significant progress had recently. The purpose of this study was using artificial neural networks to predict the moisture content of papaya in the laboratory dryer with a drying of the Cabinet. Temperature effect in three levels (40,50 and 60 degrees Celsius) and the thickness of the cut pieces (3,5 and 7 mm) on the moisture content changes were studied. MLP with three layers back propagation neural network to model the drying process was designed with different learning algorithms. Different topologies with different threshold functions were used to predict product moisture content. Results showed that the MLP network with 1-9-3 structure and learning algorithm Levenberg-Marquardt with logarithmic sigmoid threshold function with different topologies and learning algorithms provide better results. Coefficients R2 and RMSE for these networks were optimized, respectively, 0.9994 and 0.00708 Indicating the ability of artificial neural networks to model the drying of the product.

Keyword: papaya - drying - Artificial neural network - moisture content

INTRODUCTION

Papaya plants grow in tropical and subtropical regions. It tastes like the fruit of this plant family Karakas and the Taliban. Papaya fruit is very sweet and juicy. The content of arytenoids, potassium, fiber and vitamin C in fruits is the highest division [1]. Papaya production is widely in some countries According to the FAO in 2005, 6.5 million tons of papaya in the world is produced. Tropical countries like Brazil, Nigeria, India, Mexico, Indonesia, are the world's largest producers and exporters of these products [2]. The plant in Baluchistan (Booklet) grows, and in recent years has taken positive steps in the production. Drying reduces moisture content to reduce or stop the enzymatic or microbial activity and the products are produced with less weight and volume they are easier to transport and processing [3]. Many tropical crops such as papaya from biological waste from the process of harvesting is likely to be the most effective method of drying the product in reducing waste and increasing quality of this product [4]. One of the most important steps to design and optimize various types of dryers, forecasting and modeling is the process of drying. The predicted changing in the product moisture content during the drying time is important. Conventional methods based on first principles to predict the development process, a long time and accuracy of the results are not satisfactory. Artificial neural networks to predict the speed and precision power supplies are drying process. Today with the development of software to predict the drying process has been made more precise. Among these methods, artificial intelligence, which in recent years been widely used in the drying process and to simulate the drying process is in progress.

Erenturk et al. (2004), were examined the dried herb Echinacea Angustifolia root into thin layers. In this study to predict the dynamic behavior of the dried product multi-layer perceptron neural network method and regression analysis were used. Tested at three temperatures 15, 30 and 45 ° C, air velocity 0.3, 0.7 and 1.1 meters per second and the size of 3 mm or less, 3 to 6 mm and 6 mm or more was done. Four different mathematical models to fitexperimental data were used. The three-layer neural networks to estimate the dynamic behavior of drying the roots were used. The lowest error rate in determining the structure was 1-30-4. MATLAB software to assist in the investigation of a back propagation algorithm was used to train and test networks. Comparison of statistical indicators R, R2, X2 and SSR obtained from fitting the four mathematical models and neural networks, advantage of neural network approach to mathematical models in predicting the drying process [5].

Bala and colleagues (2005) Neural Network Model of a solar dryer for drying Jack Fruit (jackfruit) were used and showed that the network is well trained can well predict the drying process. (6)

Keredpybion and colleagues in 2006 using artificial neural networks shrinkage of carrot during drying was predicted. Her carrots and moisture content of the cell dimensions obtained from the microscopic images as input to the network. Optimized neural network model with R2 = 0.95 for the different modes to predict the drying shrinkage was carrots. (7)

MATERIALS AND METHODS

Artificial Neural Network Modeling

Neural networks are mathematical models that simulate the human mind that it can be treated. Using a network with input layer, hidden layer and output layer is simply an appropriate relationship between independent and dependent variables in many of the phenomena can be established. Hidden layer, and processes the information received from the input layer, are output layer. In order to apply a grid network must be trained. Education is the process by changing the weights between layers the difference between predicted and measured values would have been acceptable. The achievement of this learning process has been realized. Neural networks can be trained to predict the output with a new set of data used.

Neural networks are a variety of types of multi-layer perceptron network (MLP). Perceptron networks, it is good to have evolved by the input vectors in recent years much attention has been placed. This kind of network has problems quickly and reliably. This method of training the network is usually after publication (BP). During the training MLP network learning algorithm to BP, the calculation of the output of the network are input to the network and the values calculated from the layer before spreading. First, calculate the output layer and output layer, each layer is done, the input layer will be next. Propagation mode, the output layer are adjusted, because for each of the output layer neurons, there is good value and can help them to update the rule and the weight to be adjusted (8).

Network for education by publishing back, three steps must be performed: The front entrance to the distribution patterns of learning, the error propagation back and adjust the weights. In this model, an input signal of strengthening or weakening of the P being the size parameter W, a neuron is an electrical signal with the pw. To simplify the mathematical model, this is the nerve cell nucleus; B is the size of the input signal with another signal. The signal b to mean that it is signals to the unit size in the parameters such as b multiply (strengthening or weakening). Total precedes the size of the signal pw + b, before leaving the cell is located under the act or process other In terms of the transfer function is called. Mathematical form of the neural network model can be expressed by the following formula:

F is the transfer function. There are three models of the transfer function:

$$y = f\left(\sum_{t=1}^{n} w4xt + b\right)$$

Logarithmic sigmoid function (log sig): for each variable n is defined as follows:

$$f(n) = \frac{2}{1+e^{n}}$$

Tangent sigmoid function (Tansig): the variable n is defined as follows:

$$f(n) = \frac{2}{1+e^{-2n}} - 1$$

Linear transfer function (Purelin): for each variable n is defined as follows:

$$f(n) = n$$

Network for three commonly used learning algorithm. The training algorithms were: Algorithm Lvnbrg - Mark art (LM), conjugate gradient algorithm (SCG) and the flexible back propagation algorithm (RP).

Product

Papayas used in this study were obtained from the local market area Bahoklat. Papaya purchased at 4 ° C cold storage was part of the food Industry. The skin of a stainless steel knife and seven pieces of the product with a thickness of 3.5 mm was prepared. The oven temperature by 70 degrees in parts of water for 8.5 hours according to Equation 1 was measured.

$$M_n = \left(\frac{W_w - W_d}{W_w}\right) \times 10($$

The basic equation that moisture MN (papaya) on a wet basis, WD final weight after drying it is. Papaya 85.49 percent based on the initial moisture content was measured by wet equation 2 is based on a dry basis moisture content was determined by the degree of MR.

$$MC_{db} = \left(\frac{MC_{wb}}{1 - MC_{wb}}\right) \times 100$$

MCdb percent moisture based on dry and wet is MCwb percent moisture basis. MCdb was 589.18% for papaya. After being cooled to about room temperature storage of papaya C 1 ± 24 hit Cm cubes were prepared. For measuring changes in sample weight during drying time, product, initially prepared slices with 0.01-weight by digital scale and then the metal mesh attached to the scales were out of the device (Figure1). Sample weight changes were recorded every five minutes. Cabin dryers used in this study have the ability to control temperature; speed and humidity were the parameters that were shown on screens mounted on the machine. Absolute humidity of the air dryer and air velocity of 0.9 meters per second was 0.6%. 589.18% of initial weight with water up to 1 ± 20%

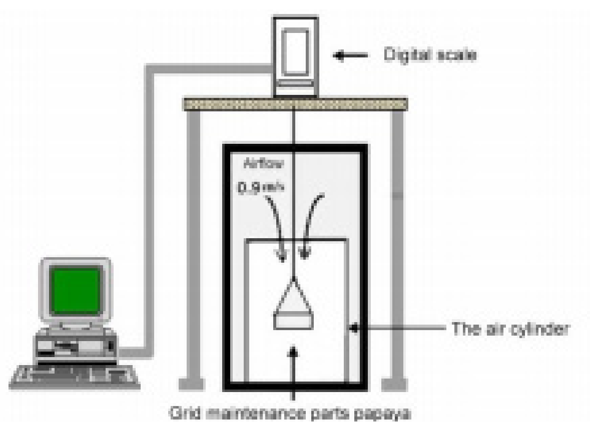

Fig.1. Weighing in drier parts of papaya cabin

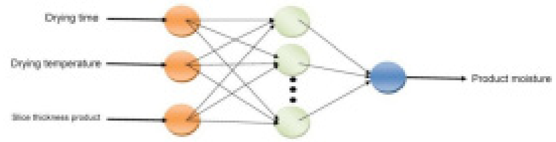

Fig.2.

humidity was performed. The process of drying papaya at three temperatures 40, 50 and 60 ° C was studied. MR changes after the end of the drying process the drying time was achieved. The definition of the MR MR = (M-Me) / (M0-Me) is obtained (9).

Me being a bad thing because the equation M0 M and M / M0 is defined by (10).

Neural networks, statistical factors based on data from R2, RMSE product was obtained. Finally, to determine which way the model has better performance, compared to the statistical factor R2, RMSE were used.

Design of Artificial Neural Networks

Three drying temperature, time and cut pieces of thick, is defined as the network input and changes in moisture content during drying is achieved. Layer neural network with three input neurons (temperature, time and cut thick pieces) and output layer neurons (changes in moisture content) was designed. Figure 2, the neural network structure and parameters of the network input and output for the show. The network topology is worthy of the kind before. Matlab 7.5 software was used in this study. The network structure is important to note that the number of input and output layer neurons should be equal to the number of input and output variables, but the number of neurons to determined empirically. The study was considered a middle layer. Figure 2. The neural network used 60% of total data for network training, 20 percent and 20 percent for test data to evaluate the network was used. After training the network model data obtained by the second batch was run. Model outputs were compared with observed values. If the model was low, the training phase was repeated until the desired result is achieved. The test was performed for the final model. For neural network training algorithms mentioned Tuesday with the help of a suitable topology, the mean square error criterion and the coefficient of determination (R2) was used for data prediction. Before using the network, all data by following the normal range were 0.5 and 9.5:

$$X_n = 0.05 + 0.9\frac{X_r - X_{min}}{X_{max} - X_{min}}$$

Xr and Xn, respectively, normalized data and Xmin and Xmax are the minimum and maximum data.

CONCLUSION

Effect of temperature and moisture content changes in the thickness of the pieces cut on the product are shown in Figures 3 and 4. In order to evaluate the performance of MLP networks, the number of neurons in middle layer and different transfer functions were used.

The training algorithm is given by the trained network. Factor of two criteria for selecting the most appropriate network and minimummean square error was calculated based on the most appropriate topology. The results are shown in Table 1. Lvnbrg algorithm compared to other learning algorithms that provide better results. The threshold function Logsig better use of their shows. 1-9-3 network topology, logarithmic sigmoid threshold function with LM learning algorithm topology other than the lowest training error (0.007084971) has produced. Learning how these networks can be seen in Figure 5. The topology changes in moisture content with the coefficients predicted 0.9994. The results show the capabilities of neural networks as a tool to predict the moisture content changes with time, the dryer can be used in control systems.

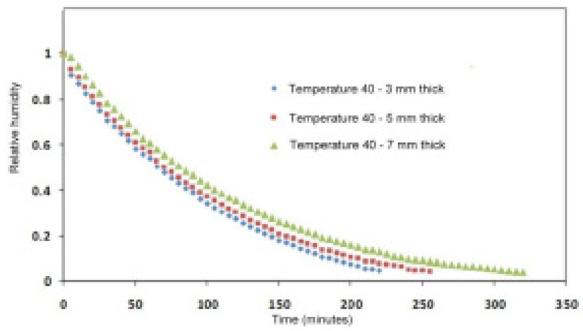

Fig.3. Thickness effect on the moisture content changes with time, temperature ° C 40

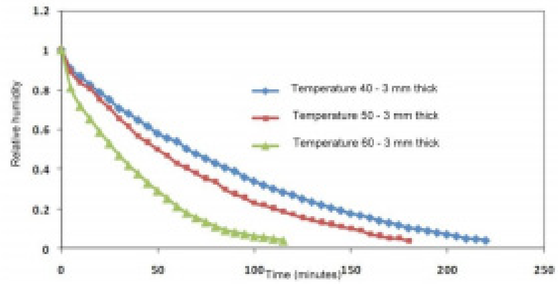

Fig.4. Effect of temperature on moisture content changes with time in 3 mm thick

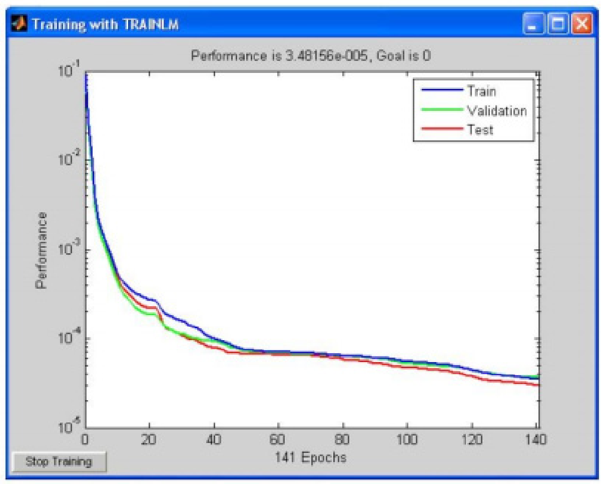

Fig.5. The training of MLP network with 1-9-3 topology, learning algorithm and transfer function Logsig Marquardt-Levenberg

Table.1. The results of the different network topologies and learning Algorithms.

Learning algoritham	Topology	R^2		RMSE	
		Tansig	Logsig	Tansig	Logsig
LM	3-3-1	0/9975	0/9985	0/0136329	0/010716637
	3-5-1	0/9887	0/9991	0/0096471	0/008223857
	3-7-1	0/9992	0/9994	0/0076131	0/007128405
	3-9-1	0/9991	0/9994	0/0078399	0/007084971
	3-11-1	0/999	0/9993	0/0085964	0/007166621
	3-13-1	0/9946	0/9988	0/01964	0/009578597
	3-15-1	0/9985	0/9991	0/010836	0/00803345
	3-17-1	0/9991	0/9993	0/007988	0/007466478
	3-19-1	0/9985	0/9989	0/0102884	0/008881159
SCG	3-3-1	0/9935	0/9655	0/0209873	0/04827556
	3-5-1	0/956	0/9945	0/0545931	0/019462045
	3-7-1	0/9914	0/9902	0/0241216	0/025966291
	3-9-1	0/9948	0/9818	0/0188818	0/035243464
	3-11-1	0/9967	0/9788	0/0151477	0/037838135
	3-13-1	0/9733	0/9892	0/0426894	0/027513329
	3-15-1	0/9934	0/9938	0/021158	0/020492507
	3-17-1	0/9924	0/974	0/022816	0/042025444
	3-19-1	0/9873	0/9782	0/02959	0/038446529
RP	3-3-1	0/9969	0/9934	0/014505	0/021267577
	3-5-1	0/995	0/9937	0/018646	0/20780025
	3-7-1	0/9955	0/969	0/017667	0/045789188
	3-9-1	0/8739	0/989	0/092767	0/027766144
	3-11-1	0/8634	0/9899	0/097368	0/026303483
	3-13-1	0/9764	0/9883	0/040098	0/028146494
	3-15-1	0/9881	0/9929	0/028469	0/02229109
	3-17-1	0/9926	0/986	0/022311	0/030891439
	3-19-1	0/9766	0/9954	0/039761	0/017464509

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