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Research Article

Safety Prediction Analysis of the Agricultural Products Processing Based on the BP Neural Network

Jing Li and Da-en Huang Fu
College of Information Engineering, Kaifeng University, Kaifeng, Henan 475000, China

Abstract: By using BP neural network algorithm, this study aims at prompting the accuracy of safety prediction of the agriculture products processing. The science prediction of the deep-frozen dumplings' shelf-life has an important guiding significance for human health and the safety of quick-frozen food. Artificial Neural Network (ANN) is a kind of information processing system which is established by simulating the human nervous system. Based on these, by using the effective theory of integrated temperature combined with BP neural network method to predict the shelf-life of the frozen dumplings in this study, we aim at providing a theory basis for monitoring and controlling the quality change in the storage process of deep-frozen dumplings' temperature fluctuations. Finally, an example is given to show that it is very effective by using the method adopted in this study.

Keywords: ANN, BP neural network, deep-frozen dumplings, prediction

INTRODUCTION

Because of its convenience, delicacy and nutrition, deep-frozen dumplings have become the mainstream in frozen food. And the sales of deep-frozen dumplings have captured 70% of all the deep-frozen food categories (Song *et al*., 2010). In the circulation process, deep-frozen dumplings will lead to a brief cold chain interruption which is influenced by each link like that the production, transport, sale and so on. Then it will lead to about five degrees' fluctuation for the storage temperature. However, deep-frozen dumplings' quality is greatly affected by the storage time and temperature (Wang *et al*., 2007). Therefore temperature fluctuations will eventually lead to the change of shelf-life. The prediction of food's shelf-life is mainly for constant temperature conditions at present (Bishop, 1994). But the change of food quality under the condition of constant temperature storage cannot reflect the actual storage conditions very well. Meanwhile the research on temperatures fluctuation are still lacking. Based on the above reasons, the science prediction of the deep-frozen dumplings' shelf-life has an important guiding significance for human health and the safety of quick-frozen food (Siripatrawan and Jantawat, 2008).

Artificial Neural Network (ANN) is a kind of information processing system which is established by simulating the human nervous system (Wu *et al*., 2007). It can solve the prediction problem of temperature fluctuation based on its large amount of properties, like self-learning, self-organizing and self-adapting. In recent years, by using BP artificial neural network's own advantages for successful application in such as economy, mechanical predicting field, etc., some scholars at home and abroad have provided the feasibility to solve the problem of food storage quality prediction. Accumulated temperature is a index that a relationship between temperature, time and the development rate of biological organisms is researched in the field of biology. However the change of quick-frozen dumplings' quality in the storage process is mainly influenced by the storage time and temperature (Wu *et al*., 2007).

In this study, by using the effective theory of integrated temperature combined with BP neural network method to predict the shelf-life of the frozen dumplings, we aim at providing a theory basis for monitoring and controlling the quality change in the storage process of deep-frozen dumplings' temperature fluctuations.

A MATERIALS AND PROCESSING STEPS

Step 1: Mterials and reagents: The quick-frozen dumplings stuffing pork and celery. To ensure the uniformity of test materials, all the deep-frozen dumplings needed in the experiment are provided by the quick-frozen food enterprises whose Lot Number is 20110316. The main reagents is shown in Table 1.

Step 2: Instruments and equipment: The main instruments used in this study is given in Table 2.

Step 3: The method of sensory evaluation First of all, set up a 10-man sensory evaluation team. Secondly, put deep-frozen dumplings into boiling water for 10 min (Li *et al*., 2010). In this

Corresponding Author: Jing Li, College of Information Engineering, Kaifeng, Henan 475000, China

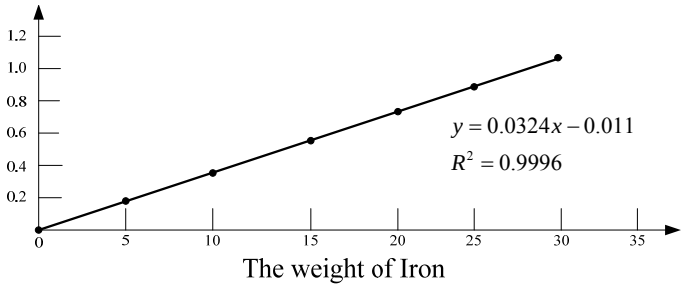

Fig. 1: Standard curve of lipid oxidation

Table 1: Main reagents

The name of reagents	The level of reagents
Iron chloride	AR
Absolute ethyl alcohol	AR
Sulfuric acid	AR
Hydrochloric acide	AR
Chloroform	AR
Petroleum ether	AR
Methanol	AR
Anhydrous ether	AR
Potassium thiocyanide	AR
Sodium	AR
PCA	-

Table 2: Main instruments

The name of instruments	Type
Water circulating multi-purpose vacuum pump	SHZ-D(III)
Vapour-bathing constant temperature vibrator	BS-S
Haier smart temperature record chip	-
Pipette	0.1-1000ul
Automatic colour difference meter	SC-80C
Rotary evaporators	R201B-II
mini-shakers	WH-966
ultraviolet-uisible spectrophotometer	T6
PolyScience	HH-501
Electrothermal constant-temperature dry box	DHG-9143B5III
Electronic balance)	FA2004A
Medical low temperature freezer	MDF-U5412
Tweezers and scissors	-
autoclave sterilizer	HVE-50
cleanser	KQ-300VDB

study flavor and general acceptance are selected as the main indexes of sensory evaluation.

Step 4: The determination method of moisture content (Getu and Bansal, 2007). Take a clean evaporating dish and put it in the drying oven under 105 centigrade scales to heat for 40 min, then take it out and cover. Dry cooling for 0.5 h, weighing and repeat to constant weight. The moisture content in samples is calculated by the following formula, that's:

$$x = \frac{m_1 - m_2}{m_1 - m_3} \quad (1)$$

where,

x = The moisture content

m_1 = The weight of evaporating dish and samples

m_2 = The weight of evaporating dish and the samples after drying

m_3 = The weight of evaporating dish, all the unit of them is g

Step 5: The determination of dumpling skin whiteness. The determination method is as follows. Firstly, ST-BD is warmed up for 10 minutes in advance. Then ST-BD is corrected by standard black cartridge and whiteboard after preheating.

Step 6: The determination of acid value. Acid Value is calculated by the following formula, that's:

$$X = \frac{V \times c \times 56.11}{m} \quad (2)$$

where,

X = The acid value of samples

V = The consumption volume of potassium hydroxide standard titration solution.

C = The actual concentration of hydroxide standard titration solution

m = The weight of samples

Step 7: The determination of peroxide value. According to national standard GB/T 5009.37-2003. The standard curve used in this study is obtained by experiment as shown in Fig. 1.

Step 8: The design of temperature fluctuation. For the storage quick-frozen dumplings to make a -28~12°C wave processing. Then after 12 h intervals to make a temperature-control in a range of 8°C and use temperature record chip to record fluctuations. Set 48 h as a wave cycle, every 5d timing to make s determination for the chemical indexes and sensory quality of quick-frozen dumplings. Finally, make three parallel tests and averaging.

Step 9: The processing of effective storage integrated temperature. According to the formula:

$$K = \sum_{i=1}^{n} N(T_i - C)$$

to calculate the effective integrated temperature. Where K is the effective integrated temperature, T is the actual test storage temperature, C is the

relative zero, N is the storage time, n is the record number of deep-frozen dumplings in the process of storage by temperature chip.

BUILD UP THE FORECAST MODEL

The neural network of BP: The neural network of BP, named multi-layer feed-forward back vividly by the network, usually consists of input layer, output layer and several hidden layers, each layer is composed of a number of nodes, each node said one neuron, asked by a weight of upper nodes and the lower nodes connection, Weights of each layer can be adjusted through learning, between layer and layer node adopts full Internet connection (Gacula, 1975). There is no link between nodes in each layer. Three layer BP neural network's nonlinear mapping ability is stronger. This study choose a three layers structure of BP neural network, Contains the input layer and output layer and hidden layer, structure is shown in Fig. 2.

The choice of input and output factor: The BP artificial neural network requirements to training the network with multiple sets of input, this study of the communist party of China 21 group of p and t vector group were collected for analysis. Input vector P is composed of six elements, Are: frozen dumplings original flavor, the initial general acceptance, dumpling skin initial water content, dumpling skin whiteness, initial acid value, peroxide value, The output vector t, contains only one element, namely storage effective accumulated temperature of frozen dumplings, The experimental data can be divided into two parts, Section contains 16 group vector, matrix composition training, used to construct the network structure and train the network, Another part of the vector for the remaining 5 groups, form validation matrix p-test and t-test, are used to trained network for validation. Initial data is collected for experiment of different orders of magnitude, the data input to the network weights are different, for some weights of small elements, are easy to be computer misjudgment of 0, But in fact this misjudgment just is the result of an order of magnitude difference is too big, So before the BP network training, the data must be normalized processing, To reduce the change fan with 0~1, normalization formula is as follows:

$$p' = \frac{p - \min(p)}{\max(p) - \min(p)} \tag{3}$$

The determination of the bp network structure: This study chooses the BP neural network structure of the concrete parameters: an input layer, contains six elements; An output layer, containing a element, A hidden layer, as to the number of hidden layer nodes, Is a more complex problems, according to the empirical formula:

$$L_k \le \sqrt{m(n+3)} + T$$

L_k = The number of hidden layer nodes
M = Input layer node number
n = Output layer node number
T = The sample

$$n_1 = \sqrt{n+m} + a$$

where,
m = The number of output nodes
n = The input node number
n_1 = The number of hidden layer nodes
A = Constant between 1-10, Get a range of 7~20

Choose a different number of hidden layer neurons BP artificial neural model is set up, according to the number of training after the network training and

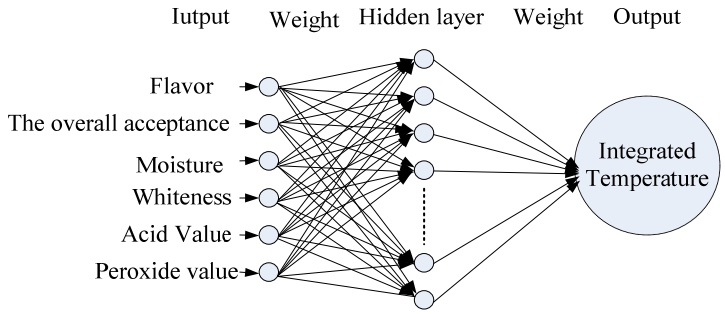

Fig. 2: Quick-frozen dumpling shelf-life prediction model based oil BP neural network

Table 3: The error of network training

The network error of hidden layer	7	8	9	10	11	12	13
The network error of hidden layer	0.6378	0.3421	0.1543	0.2406	0.1245	0.1127	0.0759
	14	15	16	17	18	19	20
	0.1259	0.4257	0.3678	0.2103	0.0934	0.5127	0.4186

network mean square error value, choose training fastest and minimum mean square error of the number of hidden layer elements, When the number of hidden layer nodes in this experiment to 13 network performance is optimal, so the number of hidden layer neurons to 13, The network model has six input layer neurons, the middle layer has 13 neurons, Middle layer neurons of the transfer function for tansing s-shaped tangent function, the transfer function of neurons in the output layer is pure purelin linear function, network of trainlm function. Table 3 is the error of network training in the following.

THE RESULTS AND ANALYSIS

The experimental data: Based on experiment and sensory evaluation index of low temperature storage of frozen dumplings as sample, in the process of simulation of quick-frozen food actual circulation storage temperature, determination of in -28~-12°C temperature fluctuations under the condition of effective accumulated temperature of frozen dumplings. According to the measured experimental data, the storage and effective accumulated temperature of h. 40332°C as the shelf life of frozen dumplings end point. Data samples can be divided into two groups, random pick 16 sets of data as a training set, the rest of the 9, 12, 13,1 6, 17, 5 sets of data, such as test set. Table 4 is for low temperature storage after normalized storage effective accumulated temperature of frozen dumplings, the sensory evaluation value and lipid oxidation measurements.

Frozen dumplings and effective accumulated temperature prediction: This study momentum constant take 0.9 in network training, learning rate is 0.05, the training of the person count set to 10000, network performance target error of 0.001.Using sample data to generate the trained BP network prediction model, after 4484 times training, revised network weights for the mean square error is 0.001 (Getu and Bansal, 2007), achieve the purpose of the training, training convergence diagram as shown in Fig. 3. In Fig. 4, it is relied on behalf of effective accumulated temperature measurements, i.e., the real value and on behalf of the effective accumulated temperature of predicted value. As can be seen from the Fig. 4 effective accumulated temperature deviation is small and the actual and estimated values of maximum error is 3.18%, prove that the fit of the model predicted values and the real value is higher (Su *et al*., 2009).

BP network output test results are shown in Table 2 to 6, the predicted values in Table 5 to the normalized processing, can get the actual storage effective accumulated temperature prediction results, the actual forecast results are shown in Table 6, can be seen from Table 6 shelves the forecast at the end of accumulated temperature and the maximum error of the measured accumulated temperature was 3.18%, the forecast effect is ideal.

The model validation: To test and verify the availability of the model, will be in 15 ℃ under the condition of storage for 15 days, 25 and 45 large frozen dumplings respectively using BP neural network model of mercury 1 dynamics model to predict the remaining shelf life and calculate the residual accumulated temperature were analyzed, the relative error are shown in Table 7, from Table 7 can see mountain two models of the error is 3.48%, visible using BP neural network

Table 4: The normalized values of the test indicators

Number	Effective storage integrated temperature	Flavor	The overall acceptance	Moisture	Whiteness	Acid value	Peroxide value
1	0	1	1	1	1	0	0
2	0.023	0.974	0.949	0.938	0.926	0.057	0.010
3	0.049	0.923	0.897	0.887	0.903	0.107	0.034
4	0.074	0.846	0.872	0.835	0.814	0.176	0.040
5	0.100	0.795	0.821	0.804	0.795	0.214	0.058
6	0.156	0.769	0.769	0.753	0.793	0.252	0.087
7	0.180	0.718	0.769	0.732	0.729	0.289	0.112
8	0.203	0.667	0.692	0.701	0.709	0.333	0.123
9	0.231	0.641	0.667	0.66	0.704	0.365	0.149
10	0.256	0.590	0.615	0.629	0.642	0.390	0.187
11	0.280	0.539	0.590	0.608	0.608	0.403	0.223
12	0.303	0.512	0.539	0.577	0.597	0.415	0.257
13	0.326	0.512	0.512	0.557	0.565	0.421	0.284
14	0.348	0.487	0.512	0.536	0.505	0.428	0.307
15	0.375	0.487	0.462	0.516	0.504	0.428	0.336
16	0.398	0.487	0.462	0.505	0.489	0.434	0.359
17	0.424	0.462	0.462	0.505	0.462	0.447	0.381
18	0.449	0.462	0.436	0.505	0.461	0.453	0.401
19	0.473	0.462	0.436	0.495	0.460	0.459	0.422
20	0.501	0.462	0.436	0.485	0.459	0.459	0.452
21	1.000	0.000	0.000	0.000	0.000	1.000	1.000

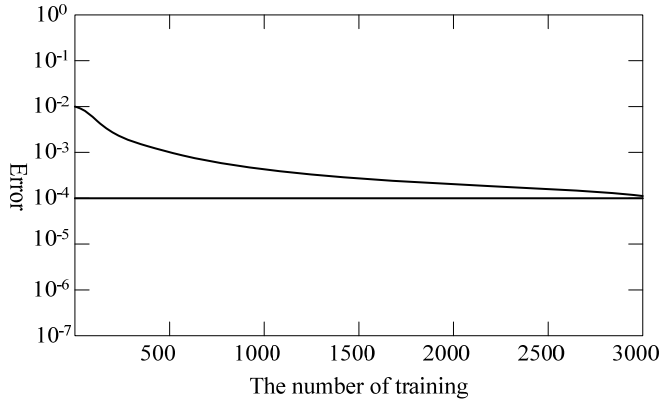

Fig. 3: Figure of training convergence of BP model

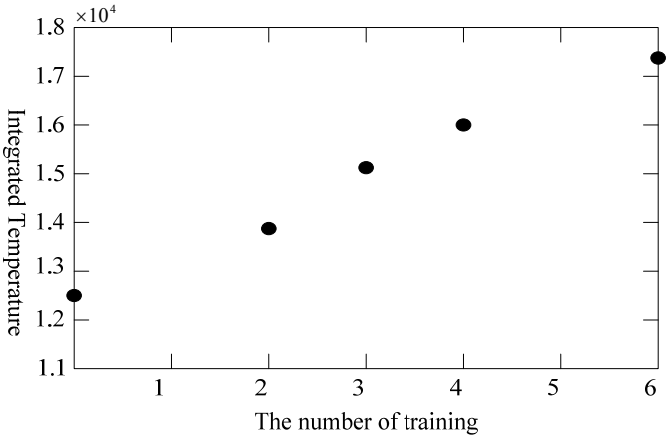

Fig. 4: The prediction results contrast figure of BP neural network

Table 5: The output value of BP neural model

The number of samples	9	12	13	16	17
Predicted effectiveness integrated temperature	0.268	0.367	0.388	0.454	0.475

Table 6: Error comparison of predictive and desired values of test samples

The number of samples	9	12	13	16	17
Predicted value of accumulated temperature	288020	255620	24684	22189	21198
Measured value of accumulated temperature	27914.5	25223.5	24407	21902	21106
Relative error	3.18000	1.34000	1.140	1.1300	0.4400

Table 7: Error of the two prediction model of the contrast

Storage time	Predicted based on BP neural	Predicted based on Kinetic models	Relative error/%
15d	35652	36504	2.39
25d	32532	33384	3.36
45d	26292	27144	3.48

model to predict the shelf life of frozen dumplings is feasible.

CONCLUSION

This study -28~-12°C storage condition, simulated the frozen dumplings storage temperature fluctuations in the process of change, for the first time through the determination of the physical and chemical index and sensory quality, establish the contact with the effective accumulated temperature and by using BP neural network model to forecast the shelf life of frozen dumplings. Results show that according to the measured data, using BP neural network model to predict that the shelves at the end of the accumulated temperature and the maximum relative error of the measured values of 3.1 8%, validate the shelf life of frozen dumplings prediction has high fitting accuracy; And dynamics model prediction are verified, the maximum relative error is 3.48%, the accuracy is higher.

In addition, the BP neural network model comprehensively reflect the frozen dumplings all factors in the process of storage on its shelf life, solved

the other prediction model in the food shelf life prediction for the limitation of fixed temperature storage conditions, more in line with the actual storage conditions, because of this model is based on the same batches of the same formula dumplings established on the basis of monitoring, in practice, should collect more different batches of dumplings again for training the model, when the training results are accurate and stable, can be applied to the same recipe dumplings shelf life prediction. This study for the first time theory is applied to the accumulation of frozen dumplings shelf life prediction, prediction for other kind of food quality will have certain reference significance.

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