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Analyzing Overall Acceptability of Burfi by Artificial Neural Network Models

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Abstract – Artificial Neural Network (ANN) model has been proposed to analyze overall acceptability of burfi stored at 4°C. In Indian subcontinent burfi is very popular sweetmeat prepared by desiccating the water buffalo milk. It is essentially and customarily served and consumed on all festive occasions and also during social gatherings. Mean square error, root mean square error, coefficient of determination and Nash - sutcliffo coefficient were used as performance measures. From the study, it is concluded that ANN models are excellent in analyzing overall acceptability of burfi.

Keywords – Burfi; Artificial Intelligence; Artificial Neural Networks; Soft Computing

1. Introduction

In Indian subcontinent burfi is very popular sweetmeat prepared by desiccating the water buffalo milk. It is essentially and customarily served and consumed on all festive occasions and also during social gatherings. Though, several varieties of burfi such as almond burfi, cashew nut burfi, cardamom burfi, chocolate burfi, coconut burfi, pistachio burfi, and plain burfi are sold in the market, but the latter variety is most popular which contains milk solids and sugar. On the upper surface of burfi pieces, a very thin edible metallic silver leaf is placed for two specific purposes, firstly the product becomes more attractive, and secondly the silver has therapeutic value [1].

Artificial neural networks (ANN) have been developed as generalizations of mathematical models of biological nervous systems. A first wave of interest in neural networks emerged after the introduction of simplified neurons by McCulloch and Pitts also known as connectionist models. ANN is a network of collections of very simple processors "Neurons", each possibly having a small amount of local memory. The units operate only on their local data and on the inputs they receive via the connections or links which are unidirectional [2]. ANN has three layers in its structure; first layer is input layer which directly interacts with external worlds; second layer is of hidden unit, where computation is done according to function provided, and the last layer is output layer, from where output is obtained. Knowledge in neural networks is stored as synaptic weights between neurons. The network propagates the input data from layer to layer until the output data is generated. If the networks is multilayer perceptron with backpropagation algorithm and the output is different from the desired output, then an error is calculated and propagated backwards through the network. The synaptic weights are modified as the error is propagated [3]. Shelf life studies provide important information to product developers and manufacturers to ensure that the consumer will continue to get a high quality product for a significant period of time after its production. Since the shelf life evaluation conducted in the laboratory is expensive and long time-consuming process, hence does not fit with the speed requirement of the food industry. Therefore, accelerated methods for estimating the shelf life of food products have been recently developed. The modern food industry has flourished because of its ability to deliver a wide variety of high quality food products to consumers. This has been achieved by building stability into the products through adopting various technological techniques like processing, packaging, and additives. Consumer's demand for convenience has fueled new innovations in the food product development. As an increasing number of new foods compete for getting space on supermarket shelves, the words "speed and innovation" have become the watchwords for food companies seeking to become "first to market" with successful products [4]. ANN models have been successfully applied for predicting the shelf life of food items *viz.*, yogurt [5], processed cheese [6-16], butter [17], milk [18], burfi [19-24], coffee drink [25-27], cakes [28] and kalakand [29]. The present study was undertaken to predict the shelf life of burfi by developing proficient ANN model, as determination of overall acceptability in the laboratory is long time consuming and costly affair.

2. Method Material

Moisture, titratable acidity (TA), free fatty acids (FFA), tyrosine, and peroxide value (PV) were used as input variables, and overall acceptability score (OAS) as the output variable for analyzing the overall acceptability of burfi. (Fig.1).

$$MSE = \left[\sum_{1}^{N} \left(\frac{Q_{\exp} - Q_{cal}}{n} \right)^2 \right] \quad (1)$$

$$RMSE = \sqrt{\frac{1}{n}\left[\sum_{1}^{N}\left(\frac{Q_{\exp} - Q_{cal}}{Q_{\exp}}\right)^2\right]} \quad (2)$$

$$R^2 = 1 - \left[\sum_{1}^{N}\left(\frac{Q_{\exp} - Q_{cal}}{Q_{\exp}^{\,2}}\right)^2\right] \quad (3)$$

$$E^2 = 1 - \left[\sum_{1}^{N}\left(\frac{Q_{\exp} - Q_{cal}}{Q_{\exp} - \overline{Q_{\exp}}}\right)^2\right] \quad (4)$$

Where,

$Q_{\exp}$ = Observed value;

Q_{cal} = Predicted value;

$\overline{Q}_{\exp}$ =Mean predicted value;

n = Number of observations in dataset.

Mean square error MSE (1), root mean square error RMSE (2), coefficient of determination R^2 (3) and Nash - sutcliffo coefficient E^2 (4) were used as prediction performance measures. Training pattern of ANN models is illustrated in Fig.2. The Neural Network Toolbox under MATLAB software was used for the development of ANN models.

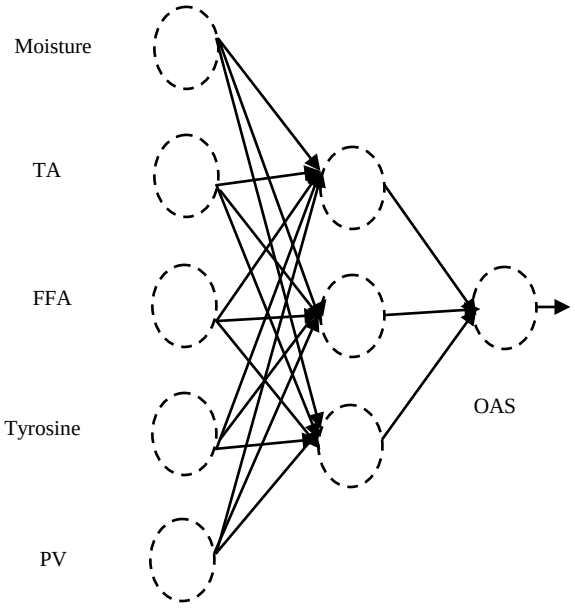

Fig.1. Input and output variables of ANN model

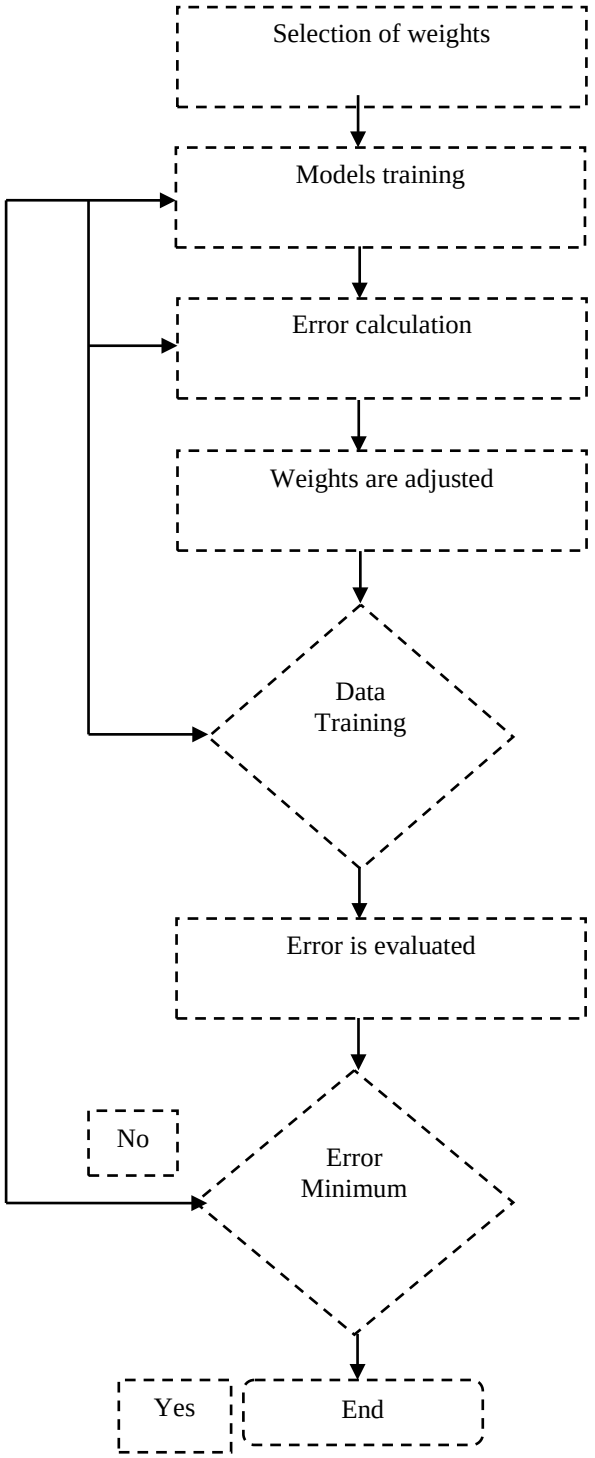

Fig.2. Training pattern of ANN models

3. Results and Discussion

ANN model's performance matrices for predicting OAS are presented in Table 1.

Table 1. Results of ANN model

Neurons	MSE	RMSE	R^2	E^2
6	5.62389E-05	0.00749926	0.99250074	0.9999437
7	1.23615E-05	0.003515892	0.99648410	0.9999876
8	3.20889E-06	0.001791337	0.99820866	0.9999967
9	3.20889E-06	0.001791337	0.99820866	0.9999967
10	**1.38889E-08**	**0.000117851**	**0.99988214**	**0.9999999**

14	2.02319E-05	0.004497985	0.99550201	0.9999797
16	2.645E-06	0.001626346	0.99837365	0.9999973
17	4.26785E-05	0.006532881	0.99346711	0.9999573
18	1.09191E-06	0.001044947	0.99895505	0.9999989

Feedforward single layer models were developed for analyzing overall acceptability of burfi stored at 4^{o} C. Bayesian regularization mechanism was chosen as training function; sum square errors as performance function. Weights and biases were randomly initialized. The ANN was trained with 150 epochs and transfer function for hidden layer was *tangent sigmoid*, while for the output layer, it was pure *linear* function. The ANN model with 5→10→1 topology (MSE: 1.38889E-08; RMSE: 0.000117851; R^2: 0.99988214; E^2: 0.9999999) gave the best results (Table 1). The modelling results suggested that there is an excellent agreement between the experimental data and predicted values with high R^2. The ANN model showed a remarkable performance. These results are very encouraging and suggest that ANNs are potentially proficient for analyzing overall acceptability of burfi.

4. Conclusion

Feedforward single layer artificial neural network models were developed for analyzing overall acceptability of burfi stored at 4^{o}C. Moisture, titratable acidity, free fatty acids, tyrosine, and peroxide value were taken as input variables and overall acceptability score as the output. Bayesian regularization algorithm was selected as training function. Mean square error, root mean square error, coefficient of determination and Nash - sutcliffo coefficient were used as performance measures. Experimental results showed 5→10→1 topology gave the best fit with high coefficient of determination and Nash - sutcliffo coefficient, suggesting that the models got very well simulated and can be used for determining the overall acceptability of burfi.

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