MODELING THE EFFECT OF ADDING HYDROCOLLOIDS ON BAGUETTE BREAD STALING USING NEURAL NETWORKS

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ABSTRACT

Wheat bread as an integral part of the food basket is of paramount importance to meet the nutritional requirements and nutrient supply. Recently, there has been an increased attention to bulky breads because modern methods of processing and baking dough are in a way through which bread waste is reduced and they result in longer lasting of bread and preserve bread vitamins and proteins. Moreover, having additives in baking industry has also become more common. So that, they are generally used to improve the quality, to enhance efficiency and ease of working with dough, to delay staling, and hence to reduce waste. Neural Networks are a branch of artificial intelligence with computer algorithms on different classification and pattern recognition, parameter estimation, and so on. The aim of this research study was to use artificial network in order to predict appropriate models for the effect of adding hydrocolloids on baguette bread staling. The results showed that adding hydrocolloids would delay staling and adding guar in a long time has the greatest impact on baguette bread sustainability.

Key words*:Baguette bread, Hydrocolloids, Neural network, Stale.*

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Introduction

Basically, baking industry products during the preservation period are along with changes in their characteristics that adversely affect their quality. Reducing the degree of consumer acceptance, other than what is caused by microbial deterioration, is attributed to staling. In other words, bakery products experience complex physicochemical changes during bread-baking which is called staling. In general, the main reason of staling is reducing amount of baking bread product adoption. During this reaction, bread aroma and flavor change, the surface loses its brittle and flexibility of bread core decreases, so that the bread in the mouth is dry and stiff and needs a lot of saliva to be swallowed(1). Staling is a phenomenon which cannot be prevented under normal circumstances and even if the best materials and methods are used in the preparation of bakery industry products, it becomes stale after removing it from the oven or furnace and it loses its texture, flavor and primary and natural color(5, 2).

Dough is a viscoelastic material obtained from a mixture of water and flour in sufficient quantities(6, 7). Its physical properties depend on several factors and these factors strongly influence the dough and the final quality of the product(8). Moreover, the quality of flour, the type and level of raw materials, bread production process, and ingredients such as additives are parameters influencing technological properties of dough and bread quality(9, 10, 11).

Regarding the fact that staling phenomenon in bakery industry products reduces quality and acceptability of the final product, several studies on slowing down and delay of staling have been conducted and suggested several techniques including improving the quality of baking, bread packaging, keeping bread at a specified temperature, and the use of additives. To keep bread fresher, gluten and protein ingredients, puffing ingredients such as gelatinized and dried starch, amylose, pentose, fat and emulsifiers and hydrocolloids[12, 13]. Hydrocolloids or gums are a large group of polysaccharides and their derivatives. They are capable of producing solutions with high viscosity at low concentrations. Hydrocolloids are usually used in bulky breads to improve texture, to strengthen the gluten network, to create softness, smoothness, and to delay staling[14].

Neural Networks are a simplistic modeling of the nervous systems and are widely used in solving various problems in science. The scope of these networks' application is so widespread and includes classification applications and other applications such as interpolation, estimation, detection, etc. Perhaps, the most important advantage of these networks is their abundant capability along with their ease of use. Based on the proven performance of neural networks in modeling complex systems in many industries in which nonlinear factors are effective in changing their characteristics and also due to the impact of staling on changing qualitative characteristics of bread as one of the most important nutrients in people’s food basket, this study aimed to develop appropriate models to predict the impact of hydrocolloids on the staling delay, which can play a significant role in improving the quality of products produced. Each neural network consists of three phases: training, generalization, and implementation[15].

In the training phase, the network learns about the patterns available in input of training series. Learning capability means the ability to configure network parameters on the track in order to change the network environment. In this way, the network with little experience can also be effective in new conditions. Generalization refers to the strength of neural network to create acceptable response to the input which has not been a member of the training series[16]. In other words, in this phase the network must be able to provide an appropriate outlet against an input that is not a member of the training data[18]. In implementation phase, the neural network is used based on the function for which it has been designed. Thus, the basis of neural network is in the way that it first is trained by training data and their corresponding output.

Calculating the amount of error between the output of each training data and the estimated amount for those data, the initial weights of training data that were initially given to input data in random alter[17] and this process continues until the amount of errors reaches the minimum possible value. In this case, it is said that the network is trained[19].

Materials and methods

In this study, Setareh flour was investigated and its physico-chemical properties based on (AACC 2000) standard was measured as Gluten 26%, moisture 12%, protein 9.2%, fat 1.3%, and ash 1%. To develop and train the neural network, control samples and samples containing 1% of hydrocolloids, pectin, xanthan and guar were tested. The first layer of a neural network is called input layer which does not play any role in processing and the final layer is the output layer that shows the network response. The layer between input and output layers are called Hidden Layer or intermediate layer. Generally, properties of a neural network include network structure and connections between neurons, network training method, and the way of determining the values of each function neurons stimulating neurons[3]. Depending on each of these cases, various neural networks have been presented and in this study Multilayer Perceptron Neural Network (MLP) is used (Fig. 1).

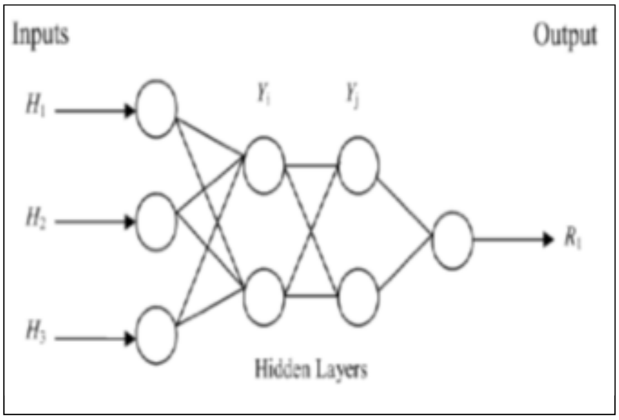

Figure 1: The structure of the neural network.

Multilayer Perceptron (MLP) Networks contain several simple perceptrons which hierarchically contain one or more intermediate layers (hidden layers) between input and output layers as well as a number of neurons in each layer[7] and these neurons are not fixed and depend on the type of work.

In other words, choosing the appropriate structure for these networks, we are able to solve many complex issues and problems[21].

Neural networks of Multilayer Perceptron network have three main features as follows:

• The activation function of each neuron in the network is a non-linear operator, e.g. Sigmoid

• The network includes one or more intermediate layers and these layers create an effective and meaningful model from the input data and make the network learn the master model.

• The network has a high level of connections which increase the network's ability to learn.

Discussion and conclusion

The neural network used in this study was developed in MATLAB software. First, all input and output variables were in the range of 1 and -1 normal. After entering and normalizing the data in the above-mentioned program, perceptron networks with different topology of one layer, two layers, three layers and four layers with different number of neurons in each layer as well as transfer functions, error function, number of training OPECs and other network parameters were tested. After preprocessing phase, hard attempts were made to reduce error function of training networks by increasing the number of hidden layers and the number of neurons. The results showed that increasing the number of hidden layers did not significantly reduce network error function; however, increasing the number of hidden layer neurons, to a certain number, reduced the error function (Fig. 2).

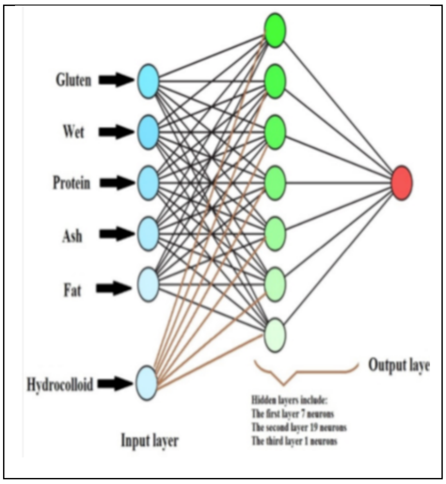

Figure 2: Structure of a neural network model to predict the effects of adding hydrocolloids on the staling of bread baguette.

Therefore, for optimization of the model in the hidden layer, different numbers of neurons were used to specify their optimum number. As a result, one to twenty neurons were used. The most important criterion for the end of the training, completion of the training cycle, completing the designated time for training was having access to training and validation mean square error set for the data. After selecting, appropriate transfer functions for hidden layers and finally the topology of the best network obtained were determined to be specified. And finally three layers of Levenberg- Marquardt algorithm were considered. In addition, the activation function for the first layer was tansig with 7 neurons, the activation function for the first layer was tansig with 19 neurons and the oputput layer consists of purelin activation function and 1 neuron.

The results suggest that the neural network with optimized topology are very efficient in anticipation of the fundamental characteristics of bread due to its unique ability in processing information and modeling complex systems with non-linear factors. Investigating the relative sensitivity factors for the output to the input network parameters in obtained models showed that the highest amount of staling is related to samples without additives and xanthan samples had minimal effect in the prevention of staling. It is also predicted that in short time (less than 40 hours), adding pectin have the greatest impact on preventing staling; however, with time intervals more than 40 hours the trend is reversed and guar has the greatest effect on preventing bread staling. There are different opinions about the mechanisms and effects of hydrocolloids.

On the one hand, it is thought that the water absorbed by the puffing ingredients is released during baking process and placed at the disposal of starch for gelatinization. On the other hand, it is proven that hydrocolloids compete with starch in water absorption and reduce it[22]. Anyway, the water increases in the product, so the effects of these additives are important to keep bread fresh[23] (Fig. 3).

Given that as bread can be regarded as an unstable and staling ingredient containing a process of physical, chemical, and sensory changes, research studies have been conducted on the properties of the bread during its durability period. The result of this study showed that adding hydrocolloids causes delay in staling and adding guar gum in a long time increases freshness of bread.

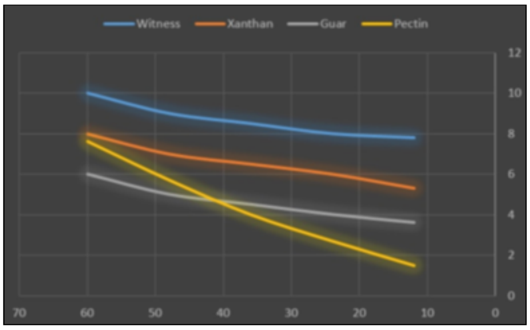

Figure 3: Baguette bread staling by adding various hydrocolloids, Modeled by neural networks.

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