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Investigating Physicochemical and Sensory Properties of Tomato Paste Using Fennel Seed Extract and Ziziphora clinopodioides Lam. and Predicting the Results Using Artificial Neural Network

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ABSTRACT

This study aimed to produce tomato paste using natural preservatives as an alternative to chemical preservatives. Fennel seed extract (Foeniculum vulgare Mill) and Ziziphora clinopodioides Lam. were used as natural preservatives.Physicochemical properties of tomato paste such as pH, acidity and total soluble solids (Brix) were measured during 5 weeks of storage at 4°C. Sensory properties of tomato paste were assessed using trained and untrained sensory evaluators using a 5-point hedonic scale.To predict the data from an artificial neural network of topology 2-37-1, storage period and different concentrations of fennel seed extract and Ziziphora clinopodioides Lam. were considered as inputs and acidity as the target parameter.The results showed that using different concentrations of fennel seed extract and Ziziphora clinopodioides Lam. significantly reduced ($p < 0.05$) the pH and increased the acidity of tomato paste.Increasing the level of extracts in tomato paste samples significantly ($p < 0.05$) increased Brix during storage period.Sensory evaluation showed that in terms of color, appearance and consistency treatments containing low concentrations of the extracts (0.5 and 1% of both extracts) scored higher.In terms of taste and smell, treatments 3 and 4 (containing 2 and 3% of fennel seed extract, respectively) had the highest score.In general, it can be concluded that using 2 or 3% fennel seed extract as a natural preservative in tomato paste leads to desirable physicochemical and sensory properties.The results of acidity prediction showed that the correlation coefficient and the mean squared error for the total data were 0.99232 and 0.00002, indicating a successful prediction.

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1. Introduction

In this century, maintaining the safety of food and its quality during the shelf life is something that has not only attracted the attention of food industry specialists and health officials of countries, but neglecting it or not paying enough attention to it can cause irreparable damage to the society. . Today, diseases caused by the consumption of contaminated food are considered a major problem all over the world, even in advanced countries such as the United States. According to the reports of the World Health Organization ([1]WHO) Diseases caused by consumption of contaminated food and water kill 2.2 million people in the world every year, 1.9 million of whom are children. According to these reports and the need to ensure the food security of the society, the production of healthy, safe and quality food is one of the important goals of food producers [1]. Currently, the use of chemical preservatives is the most common way to maintain safety and health. The food is during the storage period. In addition to harming the consumer's health, spoiled food also causes economic damage to the producer. Consumers' lack of confidence in the safety of food containing synthetic preservatives, on the other hand, the reports of the toxic effects that these preservatives leave in the body [2], have led people to natural foods, which do not contain these chemical preservatives. In them, natural products or compounds derived from them are used as substitutes for preservatives and at the same time have the ability to be stored in the desired period of time [4-3]. Among the natural compounds that can be used as preservatives in food Plant essential oils are used. Plant extracts and essential oils obtained from aromatic plants have antibacterial, antifungal, antioxidative and anticancer properties and are able to control the growth of pathogens and the production of toxins by microorganisms [4]. Research by researchers shows that among the known medicinal plants, plants with more phenolic compounds in their essential oils have remarkable antimicrobial properties [5]. The examination of extracts extracted from different parts of the fennel plant shows that it is able to neutralize Free radicals are the result of oxidation. The presence of phenolic compounds and fatty acids such as oleic, linoleic and palmitic acids in different parts of this plant can be effective in its antioxidant activity. In addition to the phenolic and antioxidant properties of fennel seed extract, this extract also has antifungal and antimicrobial compounds [6]. Morales et al [7] investigated the effect of natural extracts (oregano, thyme, cinnamon, paper flower and green tea) on the formation of acrylamide in fried potatoes. Their results showed that green tea, cinnamon and oregano extracts reduced the level of acrylamide by 62, 39 and 17%, respectively. Potatoes immersed in paper flower and cinnamon extracts had different color parameters than the control potatoes. However, no significant difference was found in tissue and peroxide values. Sensory evaluation also showed that the acceptance of potatoes was not affected by the treatments used. Therefore, it was found that pre-treating potatoes with antioxidants before frying will have a beneficial effect on reducing the amount of acrylamide, without causing significant changes in their physicochemical, sensory and textural properties. Altankaya et al. [8] evaluated the oxidative stability and chemical safety of mayonnaise enriched with grape seed extract. These researchers enriched mayonnaise with different levels of grape seed extract and stored it at room temperature for 8 weeks. The results of their study showed that the highest antioxidant capacity and the lowest content of lipoperoxide (peroxide index) and

[1]- World Health Organization

thiobarbituric acid index were found in the mayonnaise sample containing the highest percentage of grape seed extract. Therefore, the oxidative stability of mayonnaise enriched with grape seed extract slightly increased its shelf life. However, in terms of sensory characteristics, the sample of mayonnaise without grape seed extract had the highest acceptability compared to enriched samples. Saluti [9] investigated the effectiveness of garlic as a preservative in tomato paste industries. During this research, fresh garlic and garlic extract were used with concentrations of 0.125, 0.25, 0.5, 0.75, 1, 1.5, 2, 2.5 and 3%. The results of his research showed that the minimum inhibitory concentration (MIC) of fresh garlic and garlic chloroform extract in tomato paste were: 3% and 0.5%, respectively. In terms of the effect of garlic on the chemical, physical and taste characteristics of tomato paste, the results showed that fresh garlic and garlic chloroform extract had no significant effect on the chemical and physical properties of tomato paste, but the changes made in the taste of tomato paste Ferengi was evaluated as favorable or unfavorable depending on the personal taste of the people.

Vakili [10] investigated the effect of fennel and thyme plant extracts with and without flax on the yield and quality of eggs produced by laying hens at the age of 26 weeks. The experiment was conducted in the form of a completely randomized design with 200 chickens in 5 treatments and 5 replications and 8 laying hens in each replication for 12 weeks. Alcoholic extract of fennel and thyme plants was used in the amount of 40 milliliters per kilogram of feed. The results showed that the effect of the experimental treatments on egg laying percentage, total weight of eggs produced and feed conversion ratio was insignificant and on the average weight of eggs and also the total feed consumed in the whole period was significant ($P<0.05$). The yolk color index in the treatment containing thyme and flax showed a significant difference with other treatments ($P<0.05$). The results showed that thyme and fennel extracts improved the performance of laying hens and egg quality factors, and the combined use of flax seed With thyme, it improved the composition of fatty acids and cholesterol in the yolk. Tabatabai et al.] 11 [The effect of using Chubak plant extract at three concentration levels (0.5, 1 and 1.5% w/w) on the rheological properties of the samples containing the extract and the control sample by the well-known rheological models (Bingham, Herschel Balakli, Casson and the power law)) and fitted it using Bostwick's consistency meter and Brookfield's viscometer. The addition of this hydrocolloid compound to the ketchup formulation in the mentioned concentrations and the passage of time had a significant effect on the consistency of the samples ($P<0.05$) and improved the textural and qualitative characteristics of the ketchup. Also, considering the highest coefficient of explanation, the most suitable model for predicting the flow behavior of all samples is Bingham's rheological model.

In a study conducted by Mokhtarian et al. [12], in order to predict the moisture content of dried tomato slices, two smart tools such as artificial neural network (ANN) and genetic algorithm (GA) were used. For this purpose, first, 4 mathematical models were extracted from other studies and then they were matched with the experimental data and the best fitting model was selected for the tomato drying curve. According to the results, the proposed model showed a very good performance in order to predict the moisture ratio of dried tomato slices. In addition, the genetic algorithm to optimize the best model

was used experimentally. Finally, the results of this research were compared with the results observed in artificial neural network models and genetic algorithms. The results showed that the genetic algorithm model provides higher accuracy in order to predict the moisture ratio of dried tomatoes with a correlation coefficient of 0.9987.

In the current study, the effect of using fennel seed extract and mountain kakuti plant on the physico-chemical and sensory properties of tomato paste is evaluated. It can be said that less studies have been conducted on the physico-chemical properties of tomato paste using the mentioned extracts. Is. The innovation of the present study is the use of artificial neural network in predicting data with a certain number of neurons. Also, the input parameters to the artificial neural network, including the length of the storage period and different concentrations of fennel seed extract and mountain cockatoo, as well as acidity, were considered as the target parameters, and finally the accuracy of the perceptron neural network will be evaluated using the mean squared error and correlation coefficient.

2- Materials and method

Tables 1 and 2 show the tested materials and equipment.

Table 1. The materials used in this study

Material	country	Manufacturer Company
Tomato paste	Iran	One Oh One
They are cyphora clinopodioides Lam.	Iran	Zanjan area
Fennel seed	Iran	Atary
Ethanol	Germany	Merck
Normal soda 0.1	Germany	Merck
0.1 Silver nitrate	Germany	Merck
Phenolphthalein	Germany	Merck
Potassium chromate	Germany	Merck
Buffer 4	Germany	Merck
Buffer 7	Germany	Merck

Table 2.Equipment required in this research

Country	Manufacturer	device
Germany	Memmert	**Water bath**
Germany	Memmert	**Oven**
Germany	heidolph	**Rotary**
Germany	Sartorios	**laboratory-balance(0.001)**
America	Unique	**Refractometer**
South Korea	YOU	**Magnetic stirrer**
England	Jenway	**pH Meter**
Germany	Shimadzu	**sampler**

2-1- Preparation of alcoholic extract of fennel seeds

The required amount of dried fennel seeds was purchased from Abhar Hindustan Medicinal Plants Company, and after confirmation and assurance from experienced experts in the agriculture of medicinal plants, 1 kg of seeds of this plant were turned into powder using a mill with 40 mesh, and then 30 grams It was mixed with 100 ml of ethanol 70 (with a ratio of 1 to 3) from the powdered plant in an Erlenmeyer flask. Then it was closed with aluminum foil in an Erlenmeyer flask and placed on a magnetic stirrer at room temperature (20°C) for 3 days to mix completely. After this time, the resulting mixture was filtered by Whatman 42 filter paper and the obtained solution was placed to concentrate the extract with the rotating evaporator under vacuum (rotary) Figure 1 at a temperature of 50 degrees Celsius so that it does not enter the phenolic compounds of the mill. The obtained extract was filtered for one hour with a 0.25 micron Millipore syringe filter and kept in a dark and sterilized container until use, and the temperature of the refrigerator was kept until the tests were performed [13].

2-2- Preparing the alcoholic extract of Kakuti leaves

The mountain kakuti plant was collected in the spring from the mountains of Zanjan province, Abhar city, and after being identified and confirmed by the experts of Tehran University of Science and Research, it was used. To prepare the extract, the leaves of this plant were washed. And it was placed in an oven with a temperature of 54 degrees Celsius for 24 hours to dry completely. Then the dried leaves were turned into powder using a 40 mesh grinder. In the next step, 30 grams of the powdered plant was mixed in an Erlenmeyer flask with 100 ml of ethanol 70 (with a ratio of 1 to 3). Then it was closed with aluminum foil in an Erlenmeyer flask and placed on a magnetic stirrer at room temperature (20°C) for 3 days to mix completely. After this time, the resulting mixture was filtered by Whatman 42 filter paper, and the obtained solution was placed under vacuum at a temperature of 50 degrees Celsius to concentrate the extract with a rotary evaporator, so that it does not enter the phenolic compounds of the mill. The obtained extract was filtered for one hour with a 0.25 micron Millipore syringe filter and kept in a dark and sterilized container until use, and the temperature of the refrigerator was kept until the tests were performed [13].

Figure 1. Vacuum rotary device

3- Physical and chemical analysis of tomato paste with fennel seed extract

For the physical and chemical analysis of tomato paste with fennel and fennel seed

extract, first weigh 100 grams of pasteurized tomato paste and then add 0.5, 1, 2 and 3% concentrations of sterilized fennel and fennel seed extracts to the paste. Tomatoes were added and kept in an incubator temperature of 25°C ± 0.5 for 5 weeks (35 days). The analysis was performed as follows with 3 repetitions [14].

1-3- pH measurement

For this purpose, the pH device was first calibrated with buffers 4 and 7, and then the tomato paste sample was placed in the tube of this device and the pH of the samples was measured at a temperature of 20 degrees Celsius (Iranian National Standard No. 761). According to the national standard of Iran No. 761, the pH of tomato paste should be at most 3.4.

2-3- Measurement of acidity

To measure the acidity, 10 grams of tomato paste sample was mixed with 30 ml of distilled water, and after filtering, 10 ml of the filtered solution was mixed with 50 ml of distilled water and a few drops of phenolphthalein were added, and the result was 1 0.0 normal until the appearance of pink color was titrated. (Iranian National Standard No. 761).

3-3- Measurement of dissolved solids (Brix)

Brix indicates the weight percentage of solids in a solution. A refractometer was used for this purpose. At first, this device was calibrated with distilled water at a temperature of 20 degrees Celsius, and then measurements were made. For this purpose, first, tomato paste juice was taken by Whatman filter paper and a few drops of it were placed in the refractometer, and then the device was placed towards the light until the brix of tomato paste was obtained. (Iranian National Standard No. 761).

The experiments were conducted in a completely randomized design in three replications. The results of physical, chemical, microbial and sensory tests were performed to check the significant difference between the data through one-way ANOVA using SPSS.22 software, and to compare the treatment averages, Duncan's multi-range test was used. It was used at the probability level of 5% ($p<0.05$). Excel software was also used to draw the resulting graphs.

4- perceptron artificial neural network

ANN artificial neural network[2] It is an idea for information processing that is inspired by the biological nervous system and processes information like the brain. The key element of this idea is the new structure of the information processing system. This system consists of a large number of highly interconnected processing elements that work together to solve a problem. ANNs, like humans, learn by example. An ANN is configured to perform a specific task, such as identifying patterns and classifying information, during a learning process. In biological systems, learning is associated with adjustments in synaptic connections between neurons. It is a method of calculation based on the interconnected connection of several processing units. The network consists of an arbitrary number of cells or nodes or units or neurons that connect the input set to the output. In this study, due to the long network calculations, only one acidity parameter was predicted. The input data including the length of the storage period and different concentrations of fennel seed extract and mountain cockatoo were considered as input parameters and acidity as the target parameter. In acidity prediction, 70% of the data are randomly used as training data and 15% of them as test data and the rest for validation. Also Lunberg Marquardt algorithm was used in perceptron neural network. Since the number of neurons in the

[2]-Artificial Neural Network

hidden layer affects the performance of the data, a sensitivity analysis was performed on this parameter. In order to evaluate the results obtained from the mean squared error ([3]MSE (correlation coefficient)[4]R) was used [15]:

$$MSE = \frac{1}{N}\sum_{i=1}^{N} (A_i^{Exp} - A_i^{ANN})^2 \quad (1)$$

$$R^2 = \frac{\sum_{i=1}^{N} (A_i^{Exp} - \underline{A})^2 - \sum_{i=1}^{N} (A_i^{Exp} - A_i^{ANN})^2}{(A_i^{Exp} - \underline{A})^2} \quad (2)$$

In high relations A_i^{Exp} ، A_i^{ANN} And $\underline{A}$ The acidity values are the acidity results from prediction by the artificial neural network and the average acidity values. MATLAB version 2010 software was used to use the artificial neural network. As can be seen in Figure 2, the 2 input parameters include the duration of the storage period and different concentrations of fennel seed extract and mountain cockatoo, and the number of neurons in the hidden layer is 37. And the output layer also includes the acidity parameter.

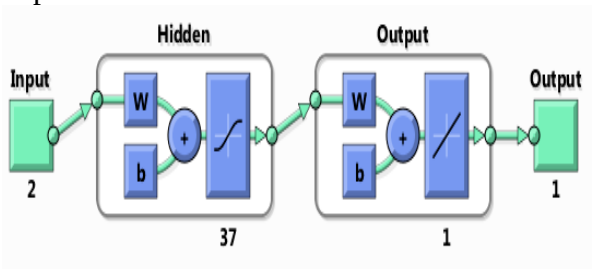

Figure 2. The schematic of multilayer perceptron network used

5- Results and discussion

5-1- pH changes of tomato paste containing extracts of fennel seeds and fennel seeds

The results of comparing the average data based on Duncan's multi-range test in terms of pH changes of tomato paste samples containing different percentages of fennel seed extract and fennel seed extract during the 5-week storage period are shown in Table 3. As the analysis of variance tables showed (Table 4), the pH changes of different samples of tomato paste during the storage period were significantly (p<0.05) was dependent on the storage time, the concentration of the extract used and the mutual effect of these two variables (time and concentration of the extract). The results of this study showed that by increasing the storage time of tomato paste containing different percentages of extract significantly (p<0.05) the pH of the samples decreased. Among the different samples, it was determined that the control sample did not contain any additives significantly (p<0.05) during different storage periods, pH is higher. Comparison of pH changes of tomato paste samples containing different percentages of fennel seed extract and fennel seed extract showed that increasing the extract percentage from 0.5 to 2% (for both extracts) significantly$p$(<0.05) pH decreased, but no significant change in pH was observed with the increase of the percentage of extracts of fennel seeds and fennel seeds from 2 to 3% (p>0.05). So that at the end of the storage period (fifth week), the highest pH (4.24) corresponds to the control treatment and the lowest pH corresponds to treatments 3 (containing 2% fennel seed extract) (3.81) and 7 (containing 2% cockatiel extract) Kohi) was (3/79).

[3]- Mean Square Error

[4]- Correlation Coefficient

Table 3. pH variations in tomato paste containing different percentages of plant extracts

Sample	First	Second	Third	Forth	Fifth
Control	0.05^{aA}±4.44	0.02^{aA}±4.42	0.05^{abAB}±4.35	0.07^{aAB}±4.34	0.29^{aB}±4.24
Treatment 1	0.02^{aA}±4.41	0.07^{abAB}±4.34	$0.20^{chapter}$±4.32	0.00^{cB}±4.10	0.03^{bcC}±3.85
Treatment 2	0.03^{aA}±4.38	0.00^{abA}±4.36	0.08^{not}±4.33	0.22^{aA}±4.30	0.01^{bcB}±3.86
Treatment 3	0.00^{abA}±4.32	0.00^{abA}±4.31	0.00^{not}±4.27	0.16^{abA}±4.26	0.02^{cB}±3.81
Treatment 4	0.00^{abA}±4.32	0.02^{abA}±4.31	0.01^{not}±4.30	0.00^{abA}±4.25	0.00^{bB}±3.86
Treatment 5	0.00^{aA}±4.42	0.00^{aA}±4.40	0.00^{aA}±4.40	0.00^{abB}±4.28	0.01^{bC}±3.91
Treatment 6	0.01^{aA}±4.45	0.00^{aA}±4.41	0.00^{aA}±4.41	0.01^{bB}±4.24	0.01^{bC}±3.92
Treatment 7	0.01^{aA}±4.47	0.00^{aA}±4.42	0.01^{aA}±4.41	0.01^{bB}±4.21	0.01^{cC}±3.79
Treatment 8	0.01^{aA}±4.44	0.02^{aA}±4.41	0.01^{cB}±4.19	0.05^{dC}±3.86	0.01^{bC}±3.86

* Different letters a-d represent significant difference at probability level 95% ($p < 0.05$).

* Different letters A-C represent significant difference at probability level 95% ($p < 0.05$).

Treatment 1 (containing 0.5% fennel seed extract), treatment 2 (containing 1% fennel seed extract), treatment 3 (containing 2% fennel seed extract), treatment 4(containing 3% fennel seed extract), treatment 5(containing 0.5% ziziphora clinopodioides Lam. extract), treatment 6 (containing 1% ziziphora clinopodioides Lam. extract), treatment 7 (containing 2% ziziphora clinopodioides Lam. extract) and treatment 8 (containing 3% ziziphora clinopodioides Lam. extract).

Table 4. pH variance analysis

Variation source	Degree of freedom	Mean squares	F	P
Storage time (A)	4	0.933	176.039	**0.000***
Sample type (B)	8	0.063	11.869	**0.000***
Interaction(A ×B)	32	0.043	8.032	**0.000***
R-Sq (R^2)	92.1%			

* Significant difference at probability level 5%.

5-2- Changes in the acidity of tomato paste containing extracts of fennel seeds and mountain kakuti

The results of the effect of different percentages of fennel seed extract and fennel seed extract on the acidity of tomato paste during different periods of storage based on Duncan's multiple range mean comparison test are shown in Table 5. The results of the analysis of variance table (Table 6) on the effect of storage time, extract concentration and the interaction of these two variables (storage time and extract concentration) on the acidity level of enriched tomato paste showed that the acidity changes significantly during the storage period (p<0.05) was dependent on the storage time and extract concentration, but the interaction of these two variables did not have a significant effect on the acidity of the samples during the storage period.p>0.05). In general, the acidity of different samples increased significantly from the first week to the fifth week with the increase in storage time (p<0.05) increased. The comparison of different treatments in terms of acidity showed that the control treatment (without any extract) during the storage period compared to other treatments significantly (p<0.05) had less acidity. Also, the comparison of the effect of adding different percentages of fennel seed extract and fennel seed extract to tomato paste showed that by increasing the percentage of the extract of each of the two plants significantly (p(<0.05) the acidity of tomato paste increased, but this upward trend of acidity was observed up to the concentration of 2%

of both extracts, and no significant difference was observed in terms of acidity by increasing the concentration of extracts of fennel seeds and fennel seeds from 2 to 3%. In the first week of storage, all the samples of tomato paste did not have a significant difference in terms of acidity, but at the end of the storage period (fifth week), the lowest acidity was in the control sample (0.506) and the highest in treatments 3 (containing 2% fennel seed extract). 0.526) and treatment 7 (containing 2% of the extract of mountain kakuti plant) (0.527) were observed.

Table 5. Acidity variations in tomato paste containing different percentages of extracts during the storage period

sample	Acidity variations during different weeks				
	first	Second	third	fourth	fifth
Control	0.00^{dD}±0.400	0.00^{eCD}±0.406	0.00^{eC}±0.415	0.02^{aB}±0.476	0.00^{not}±0.506
Treatment 1	0.00^{cD}±0.415	0.000^{dCCD}±0.423	0.00^{dC}±0.433	0.01^{cB}±0.483	0.01^{abA}±0.510
Treatment 2	0.00^{This}±0.413	0.00^{cD}±0.446	0.00^{cD}±0.463	0.01^{bB}±0.492	0.00^{abA}±0.510
Treatment 3	0.03^{aD}±0.470	0.00^{BC}±0.486	0.00^{aBC}±0.498	0.04^{aAB}±0.513	0.00^{aA}±0.526
Treatment 4	0.01^{dD}±0.465	0.02^{abC}±0.474	0.02^{abc}±0.488	0.04^{aAB}±0.509	0.01^{aA}±0.520
Treatment 5	0.00^{cD}±0.418	0.00^{dCD}±0.426	0.00^{dC}±0.434	0.00^{cB}±0.480	0.00^{abA}±0.510
Treatment 6	0.01^{bD}±0.437	0.00^{cCD}±0.444	0.00^{cC}±0.459	0.00^{bB}±0.490	0.01^{abA}±0.513
Treatment 7	0.01^{BC}±0.467	0.00^{aBC}±0.485	0.00^{aB}±0.501	0.01^{aAB}±0.516	0.00^{aA}±0.527
Treatment 8	0.01^{aD}±0.464	0.02^{abC}±0.476	0.02^{abc}±0.487	0.01^{abAB}±0.503	0.01^{aA}±0.519

* Different letters a-c represent significant difference at probability level 95% ($p < 0.05$).

* Different letters A-E represent significant difference at probability level 95% ($p < 0.05$).

Treatment 1 (containing 0.5% fennel seed extract), treatment 2 (containing 1% fennel seed extract), treatment 3 (containing 2% fennel seed extract), treatment 4(containing 3% fennel seed extract), treatment 5 (containing 0.5% ziziphora clinopodioides Lam. extract), treatment 6 (containing 1% ziziphora clinopodioides Lam. extract), treatment 7 (containing 2% ziziphora clinopodioides Lam. extract) and treatment 8 (containing 3% ziziphora clinopodioides Lam. extract).

Table 6. Acidity variance analysis

Source variation	Degree of freedom	Mean squares	F	P
Storage time (A)	4	0.051	251.357	0.000*
Sample type (B)	8	0.002	7.701	0.000*
Interaction (A×B)	32	0.000	1.327	0.150
R-Sq (R^2)	92.5%			

* Significant difference at probability level 5%

5-3- Brix variations of tomato paste containing extracts of fennel seeds and mountain kakuti

Table 7 shows the results of the comparison of the average Brix changes of tomato paste containing different percentages of fennel seed extract and fennel seed extract as natural preservatives based on Duncan's multi-range comparative test. Based on the results obtained from the analysis of variance table, it was found that the Brix changes of tomato paste containing different percentages of extract during the storage period were significantly (p<0.05) was dependent on the concentration of the extracts, the duration of storage and the mutual effect of these two variables (Table 8). In the samples enriched with different percentages of plant extracts, depending on the changes in the extract percentage, significantly (p<0.05) the amount of their soluble solids increased, on the other hand,

Brix of the control sample which did not contain any extract and preservatives increased more clearly during the storage period than other treatments. Therefore, the results showed that with the increase of storage time in the treatments containing different percentages of fennel seed extract and fennel seed extract, the treatments containing lower percentages of plant extracts significantly (p<0.05) have higher water-soluble solids compared to treatments containing higher concentrations of plant extracts. Although the treatments containing 3% of fennel seed extract and fennel seed extract did not differ significantly from each other in terms of water-soluble solids during the storage period (p>0.05), but these treatments significantly (p<0.05) had lower water soluble solids compared to other treatments.

Table 7. Brix variations in tomato paste containing different percentages of extracts during the storage period

Sample	Brix variations during different weeks				
	firth	second	third	fourth	fifth
Control	0.00^{aE}±27.50	0.00^{aD}±27.81	0.01^{cC}±28.13	0.06^{aB}±28.50	**0.10^{aA}±27.84**
Treatment 1	0.00^{bE}±27.20	0.13^{bD}±27.42	0.07^{bC}±27.62	0.07^{bB}±27.86	**0.05^{not}±27.08**
Treatment 2	0.11^{bDE}±27.16	0.10^{bcD}±27.32	0.17^{bC}±27.53	0.12^{bcB}±27.71	**0.45^{bcA}±27.92**
Treatment 3	0.01^{cD}±26.96	0.00^{cdC}±27.16	0.12^{cBC}±27.29	0.05^{cAB}±27.63	**0.07^{that}±27.81**
Treatment 4	0.01^{cC}±26.94	0.12^{dC}±27.02	0.06^{dC}±27.11	0.09^{dB}±27.38	**0.06^{and}±27.62**
Treatment 5	0.05^{bE}±27.18	0.10^{bD}±27.39	0.05^{bC}±27.64	0.16^{bB}±27.89	**0.02^{not}±28.12**
Treatment 6	0.15^{bE}±27.13	0.13^{bD}±27.34	0.14^{bcC}±27.56	0.10^{bcB}±27.74	**0.10^{bcA}±27.96**
Treatment 7	0.11^{This}±26.92	0.10^{cdD}±27.18	0.05^{cC}±27.33	0.03^{cB}±27.66	**0.12^{that}±27.85**
Treatment 8	0.20^{cC}±26.95	0.12^{dC}±27.05	0.11^{dC}±27.14	0.11^{dB}±27.41	**0.06^{and}±27.65**

* Different letters a-d represent significant difference at probability level 95% (p <0.05).

* Different letters A-E represent significant difference at probability level 95% (p <0.05).

Treatment 1 (containing 0.5% fennel seed extract), treatment 2 (containing 1% fennel seed extract), treatment 3 (containing 2% fennel seed extract), treatment 4(containing 3% fennel seed extract), treatment 5 (containing 0.5% ziziphora clinopodioides Lam. extract), treatment 6 (containing 1% ziziphora clinopodioides Lam. extract), treatment 7 (containing 2% ziziphora clinopodioides Lam. extract) and treatment 8 (containing 3% ziziphora clinopodioides Lam. extract).

Table 8. Brix variance table

Source variation	Degree of freedom	Mean squares	F	P
Storage time (A)	4	1.006	28.846	0.000*
Sample type (B)	8	3.597	103.099	0.000*
Interaction (A×B)	32	0.154	4.414	0.000*
		R-Sq (R^2)	92.3%	

* Significant difference at probability level 5%

5-4- Sensory evaluation results of tomato paste containing extracts of fennel seeds and mountain kakuti

The results of the effect of different percentages of two types of fennel seed extract and fennel seed extract during different days on the sensory characteristics (color, smell, taste, consistency and appearance) of tomato paste are shown in tables 9 to 13. As the results of the effect of different concentrations of two extracts on the color of tomato paste show (Table 9), in general, the color sensory score decreases with increasing storage time. Treatments containing 1 and 2% of fennel seed extracts (treatments 1 and 2) and mountain kakuti extract (treatments 5 and 6) during the

storage period significantly (p<0.05) had a higher sensory score in terms of color than other treatments, but these treatments did not have a significant difference in terms of color score compared to the control sample (p>0.05). Also, the use of higher concentrations of both extracts significantly decreased the sensory score in terms of color.

Table 9. Color variations in tomato paste containing different percentages of fennel seed and ziziphora clinopodioides Lam. extracts during the storage period

Sample	Color variations during different weeks				
	First	**Second**	**Third**	**Fourth**	**Fifth**
Control	0.34^{abA}±4.66	0.34^{aA} ±4.66	0.57^{aA}±4.33	0.64^{abA}±3.66	0.00^{aA}±4.00
Treatment 1	0.00^{aA}±5.00	0.57^{abAB}±4.33	0.57^{aB}±4.33	0.57^{aB}±4.33	0.57^{aB}±3.66
Treatment 2	0.00^{aA}±5.00	0.57^{abAB}±4.33	0.57^{aBC}±4.33	0.57^{BC}±4.33	0.44^{aD}±3.66
Treatment 3	0.36^{bcA}±4.33	0.00^{abB}±4.00	0.00^{aB}±4.00	0.00^{BC}±4.00	0.44^{aD}±3.66
Treatment 4	0.00^{that}±4.00	0.00^{abA}±4.00	0.44^{aAB}±3.66	0.00^{aBC}±4.00	0.44^{BC}±3.66
Treatment 5	0.00^{aA} ±5.00	0.57^{abA}±4.33	0.57^{aA}±4.33	4.33±0.57^{aAB}	0.57^{aB}±4.33
Treatment 6	0.00^{aA} ±5.00	0.57^{abAB}±4.33	0.57^{aB}±4.33	0.57^{BC}±4.33	0.00^{aD}±4.00
Treatment 7	0.57^{bcA}±4.33	0.00^{abA}±4.00	0.64^{aB}±3.66	0.44^{abC}±3.66	0.57^{aD}±3.33
Treatment 8	0.00^{that}±4.00	0.64^{not}±3.66	0.44^{aAB}±3.66	0.00^{bB}±3.00	0.57^{aBC}±3.33

* Different letters a-c represent significant difference at probability level 95% (p <0.05).

* Different letters A-D represent significant difference at probability level 95% (p <0.05).

Treatment 1 (containing 0.5% fennel seed extract), treatment 2 (containing 1% fennel seed extract), treatment 3 (containing 2% fennel seed extract), treatment 4(containing 3% fennel seed extract), treatment 5 (containing 0.5% ziziphora clinopodioides Lam. extract), treatment 6 (containing 1% ziziphora clinopodioides Lam. extract), treatment 7 (containing 2% ziziphora clinopodioides Lam. extract) and treatment 8 (containing 3% ziziphora clinopodioides Lam. extract).

The results of the effect of different percentages of fennel seed extract and mountain cockatoo on sensory quality in terms of smell are shown in Table 10. With increasing storage time, the control treatment and the treatments containing low percentages of fennel and fennel seed extracts (0.5% and 1%) lost their pleasant smell and with the passage of time significantly (p<0.05) the sensory score decreased in this respect. But with increasing storage time, treatments that contained high percentages of fennel seed extract (treatments containing 2 and 3 fennel seed extracts) significantly$p$<0.05) had a higher sensory score in terms of smell than other treatments.

Table 10. Smell variations in tomato paste containing different percentages of fennel seed and ziziphora clinopodioides Lam. extracts during the storage period

	Smell variations during different weeks				Sample
	First	**Second**	**Third**	**Fourth**	**Fifth**
Control	0.57^{not}±4.33	0.00^{aA} ±5.00	0.00^{not}±4.00	0.64^{not}±3.66	**0.64^{not}±3.33**
Treatment 1	0.00^{aA} ±5.00	0.00^{aAB} ±5.00	0.00^{aB} ±5.00	0.57^{abB}±4.33	**0.57^{aB}±4.33**
Treatment 2	0.00^{aA} ±5.00	0.00^{aAB} ±5.00	0.00^{aBC} ±5.00	0.57^{abC}±4.33	**0.44^{aD}±4.66**
Treatment 3	0.00^{aA} ±5.00	0.00^{aB} ±5.00	0.00^{aB} ±5.00	0.00^{BC} ±5.00	**0.00^{aD} ±5.00**
Treatment 4	0.00^{aA} ±5.00	0.00^{aA} ±5.00	0.00^{aAB} ±5.00	0.00^{aBC} ±5.00	**0.00^{BC} ±5.00**
Treatment 5	0.57^{not}±4.33	0.64^{not}±3.66	$0.00^{chapter}$±4.00	0.44^{bB}±3.66	**0.57^{aB}±4.33**
Treatment 6	0.00^{aA} ±5.00	0.44^{aAB}±4.66	0.44^{aB}±4.66	0.44^{abC}±4.66	**0.57^{aD}±4.33**
Treatment 7	0.00^{aA} ±5.00	0.00^{aA} ±5.00	0.00^{aA} ±5.00	0.44^{abAB}±4.66	**0.44^{bC}±3.66**
Treatment 8	0.00^{aA} ±5.00	0.00^{aA} ±5.00	0.00^{aA} ±5.00	0.44^{abAB}±4.66	**0.57^{aB}±4.33**

* Different letters a-b represent significant difference at probability level 95% (p <0.05).

* Different letters A-D represent significant difference at probability level 95% (p <0.05).
Treatment 1 (containing 0.5% fennel seed extract), treatment 2 (containing 1% fennel seed extract), treatment 3 (containing 2% fennel seed extract), treatment 4(containing 3% fennel seed extract), treatment 5 (containing 0.5% ziziphora clinopodioides Lam. extract), treatment 6 (containing 1% ziziphora clinopodioides Lam. extract), treatment 7 (containing 2% ziziphora clinopodioides Lam. extract) and treatment 8 (containing 3% ziziphora clinopodioides Lam. extract).

The results of sensory evaluation resulting from the use of different percentages of fennel seed extract and fennel seed extract in tomato paste and their effect on the taste of the final product are shown in Table 11. In general, by increasing the storage time significantly (p<0.05) the taste of the control treatment and enriched products with different percentages of fennel seed extract and mountain kakuti decreased, but the amount of this reduction was more evident in the treatments containing different percentages of kakuti extract compared to other treatments, so that at the end of the storage period, the treatments containing 2 and 3% of kakuti extract significantly (p<0.05) had a lower sensory score in terms of taste than other treatments. On the other hand, two treatments 2 and 3, which contained 2 and 3% of fennel seed extract, respectively, at the end of the storage period significantly (p<0.05) compared to other treatments had a higher sensory score in terms of taste.

Table 11. Taste variations in tomato paste containing different percentages of fennel seed and ziziphora clinopodioides Lam. extracts during the storage period

	taste variations during different weeks				**Sample**
	First	**Second**	**Third**	**Fourth**	**Fifth**
Control	0.00^{not}±4.00	0.00^{aA}±5.00	0.00^{aA}±4.00	0.54^{not}±3.66	**0.57^{abA}±3.33**
Treatment 1	0.00^{aA}±5.00	0.00^{aAB}±5.00	0.64^{aB}±4.66	0.57^{aB}±4.33	**0.64^{abB}±3.66**
Treatment 2	0.11^{aA}±5.00	0.00^{aAB}±5.00	0.44^{aBC}±4.66	0.57^{BC}±4.33	**0.00^{USA}±4.00**
Treatment 3	0.57^{not}±4.33	0.44^{abB}±4.66	0.00^{aB}±4.00	0.34^{BC}±4.66	**0.57^{aD}±4.33**
Treatment 4	0.00^{that}±3.00	0.00^{that}±4.00	0.44^{aAB}±3.66	0.34^{aBC}±4.66	**0.57^{BC}±4.33**
Treatment 5	0.00^{aA}±5.00	0.00^{aA}±5.00	0.64^{aA}±4.66	0.57^{aAB}±4.33	**0.57^{abB}±3.33**
Treatment 6	0.00^{aA}±5.00	0.44^{abAB}±4.66	0.57^{aB}±4.33	0.57^{BC}±4.33	**0.44^{bcD}±2.66**
Treatment 7	0.00^{not}±4.00	0.47^{bc}±4.33	0.00^{aB}±4.00	0.34^{cC}±2.66	**0.44^{cdD}±1.66**
Treatment 8	0.54^{that}±2.66	0.00^{and}±3.00	0.44^{aAB}±3.66	0.57^{cB}±2.33	**0.57^{dBC}±1.33**

* Different letters a-c represent significant difference at probability level 95% (p <0.05).
* Different letters A-D represent significant difference at probability level 95% (p <0.05).
Treatment 1 (containing 0.5% fennel seed extract), treatment 2 (containing 1% fennel seed extract), treatment 3 (containing 2% fennel seed extract), treatment 4(containing 3% fennel seed extract), treatment 5 (containing 0.5% ziziphora clinopodioides Lam. extract), treatment 6 (containing 1% ziziphora clinopodioides Lam. extract), treatment 7 (containing 2% ziziphora clinopodioides Lam. extract) and treatment 8 (containing 3% ziziphora clinopodioides Lam. extract).

The resulting changes in the sensory quality of tomato paste containing different percentages of fennel seed extract and mountain cockatoo in terms of consistency are shown in Table 12. As the storage time increases, the consistency of tomato paste samples generally decreases. Sensory evaluation by evaluators in terms of consistency showed that the control treatment and treatments containing low percentages of both extracts (0.5% and 1%) in general with increasing storage time from the first week to the end of the fourth week significantly (p<0.05) had higher consistency than other treatments.

Table 12. Consistency variations in tomato paste containing different percentages of fennel seed and ziziphora clinopodioides Lam. extracts during the storage period

Sample	Consistency variations during different weeks				
	First	**Second**	**Third**	**Fourth**	**Fifth**
Control	$0.00^{aA}\pm5.00$	$0.44^{aA}\pm4.66$	$0.00^{aA}\pm4.00$	$0.57^{aA}\pm4.33$	$\mathbf{0.57^{aA}\pm4.33}$
Treatment 1	$0.34^{aA}\pm4.66$	$0.57^{aAB}\pm4.33$	$0.44^{aB}\pm4.66$	$0.00^{abB}\pm4.00$	$\mathbf{0.57^{aB}\pm4.33}$
Treatment 2	$0.57^{aA}\pm4.33$	$0.57^{aAB}\pm4.33$	$0.44^{aBC}\pm4.66$	$0.00^{abC}\pm4.00$	$\mathbf{0.00^{aD}\pm4.00}$
Treatment 3	$0.57^{aA}\pm4.33$	$0.57^{aB}\pm4.33$	$0.00^{aB}\pm4.00$	$0.57^{bC}\pm3.33$	$\mathbf{0.57^{aD}\pm3.33}$
Treatment 4	$0.00^{aA}\pm4.00$	$0.57^{aA}\pm4.33$	$0.44^{aAB}\pm3.66$	$0.57^{bBC}\pm3.33$	$\mathbf{0.54^{BC}\pm3.33}$
Treatment 5	$0.34^{aA}\pm4.66$	$0.57^{aA}\pm4.33$	$0.44^{aA}\pm4.66$	$0.00^{abAB}\pm4.00$	$\mathbf{0.44^{aB}\pm4.33}$
Treatment 6	$0.57^{aA}\pm4.33$	$0.57^{aAB}\pm4.33$	$0.57^{aB}\pm4.33$	$0.44^{abC}\pm3.66$	$\mathbf{0.54^{aD}\pm4.33}$
Treatment 7	$0.57^{aA}\pm4.33$	$0.57^{aA}\pm4.33$	$0.57^{aB}\pm4.33$	$0.54^{bC}\pm3.33$	$\mathbf{0.57^{aD}\pm3.33}$
Treatment 8	$0.00^{aA}\pm4.00$	$0.00^{aA}\pm4.00$	$0.00^{aAB}\pm4.00$	$0.57^{bB}\pm3.33$	$\mathbf{0.57^{aBC}\pm3.33}$

* Different letters a-B represent significant difference at probability level 95% ($p < 0.05$).

* Different letters A-D represent significant difference at probability level 95% ($p < 0.05$).

Treatment 1 (containing 0.5% fennel seed extract), treatment 2 (containing 1% fennel seed extract), treatment 3 (containing 2% fennel seed extract), treatment 4(containing 3% fennel seed extract), treatment 5 (containing 0.5% ziziphora clinopodioides Lam. extract), treatment 6 (containing 1% ziziphora clinopodioides Lam. extract), treatment 7 (containing 2% ziziphora clinopodioides Lam. extract) and treatment 8 (containing 3% ziziphora clinopodioides Lam. extract).

The evaluation of the sensory quality of different samples of tomato paste containing different percentages of fennel seed extract and mountain kakuti in terms of appearance is shown in Table 13. With the increase in storage time, the sensory score given by the evaluators to different treatments in terms of appearance decreased significantly ($p<0.05$), but this quality loss in terms of appearance characteristics in treatments containing high percentages of different extracts (2 and 3%) compared to It was observed more clearly in the control treatment and the treatments containing 0.5% and 1% Kakuti extract and fennel seed.

Table 13. Appearance variations in tomato paste containing different percentages of fennel seed and ziziphora clinopodioides Lam. extracts during the storage period

Sample	**Appearance variations during different weeks**				
	First	**Second**	**Third**	**Fourth**	**Fifth**
Control	$0.57^{aA}\pm4.66$	$0.00^{not}\pm4.00$	$0.64^{aA}\pm4.33$	$0.57^{abA}\pm3.66$	$\mathbf{0.00^{aA}\pm4.00}$
Treatment 1	$0.57^{aA}\pm4.66$	$0.57^{abAB}\pm4.66$	$0.57^{aB}\pm4.66$	$0.00^{abB}\pm4.00$	$\mathbf{0.00^{aB}\pm4.00}$
Treatment 2	$0.64^{aA}\pm4.33$	$0.64^{abAB}\pm4.66$	$0.57^{aBC}\pm4.66$	$0.00^{abC}\pm4.00$	$\mathbf{0.00^{aD}\pm4.00}$
Treatment 3	$0.00^{aA}\pm4.00$	$0.00^{aB}\pm5.00$	$0.57^{aB}\pm4.66$	$0.57^{bcC}\pm3.33$	$\mathbf{0.64^{aD}\pm3.66}$
Treatment 4	$0.64^{aA}\pm3.66$	$0.57^{abA}\pm4.66$	$0.57^{aAB}\pm4.33$	$0.57^{bcBC}\pm3.33$	$\mathbf{0.57^{BC}\pm3.33}$
Treatment 5	$0.57^{aA}\pm4.66$	$0.57^{abA}\pm4.66$	$0.64^{aA}\pm4.66$	$0.57^{aAB}\pm4.33$	$\mathbf{0.00^{aB}\pm4.00}$
Treatment 6	$0.65^{aA}\pm4.33$	$0.57^{abAB}\pm4.66$	$0.44^{aB}\pm4.66$	$0.00^{abC}\pm4.00$	$\mathbf{0.00^{aD}\pm4.00}$
Treatment 7	$0.00^{aA}\pm4.00$	$0.00^{aA}\pm5.00$	$0.44^{aB}\pm4.66$	$0.44^{abC}\pm3.66$	$\mathbf{0.44^{aD}\pm3.66}$
Treatment 8	$0.54^{not}\pm3.66$	$0.64^{abA}\pm4.66$	$0.57^{aAB}\pm4.33$	$0.00^{cB}\pm3.00$	$\mathbf{0.57^{aBC}\pm3.33}$

* Different letters a-c represent significant difference at probability level 95% ($p < 0.05$).

* Different letters A-D represent significant difference at probability level 95% ($p < 0.05$).

Treatment 1 (containing 0.5% fennel seed extract), treatment 2 (containing 1% fennel seed extract), treatment 3 (containing 2% fennel seed extract), treatment 4(containing 3% fennel seed extract), treatment 5 (containing 0.5% ziziphora clinopodioides Lam. extract), treatment 6 (containing 1% ziziphora clinopodioides Lam. extract), treatment 7 (containing 2% ziziphora clinopodioides Lam. extract) and treatment 8 (containing 3% ziziphora clinopodioides Lam. extract).

As can be seen in Figure 3, the values of the correlation coefficient for training, validation, test data and all data have favorable values and the closer to one, the prediction process has been successful, for example, this coefficient for all The data has

a value of 0.99232 and this indicates a successful prediction of the network.

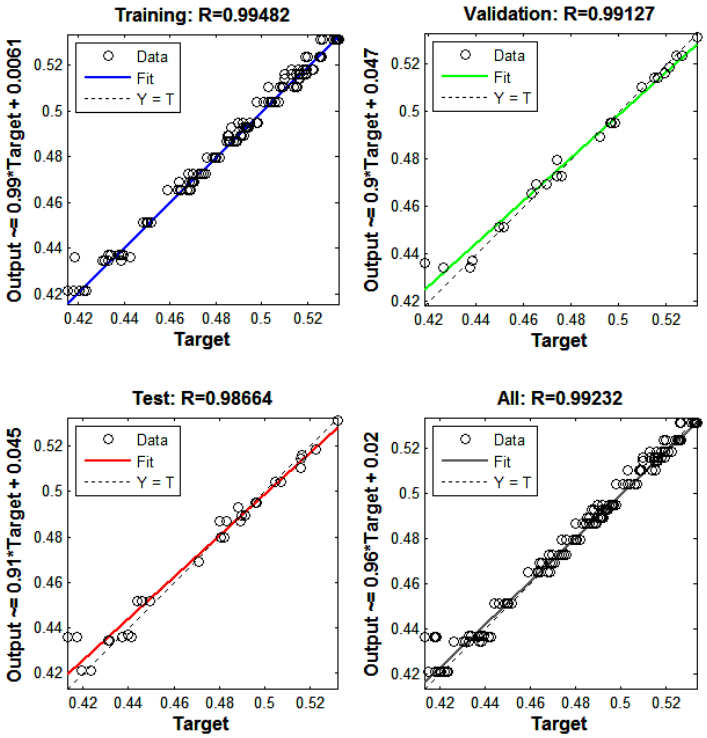

Figure 3. The obtained values of the correlation coefficient(R^2) for training, validation, test and all data from the artificial neural network (acidity)

Figures 4 and 5 show the mean squared error values. In Figure 4, it can be clearly seen that in Epoch 2, the best error result for training, validation and test data is obtained, so that this value is equal to It is 0.000029222. In fact, the downward trend of the error is very favorable and the closer we get to zero, the result is more favorable. The exact values of the mean squared error are shown in Figure 5, which is the lowest error value for the training data. Figure 6. The obtained acidity values with artificial neural network and laboratory values are compared with each other. As can be seen, most of the obtained values are in good agreement with the laboratory values.

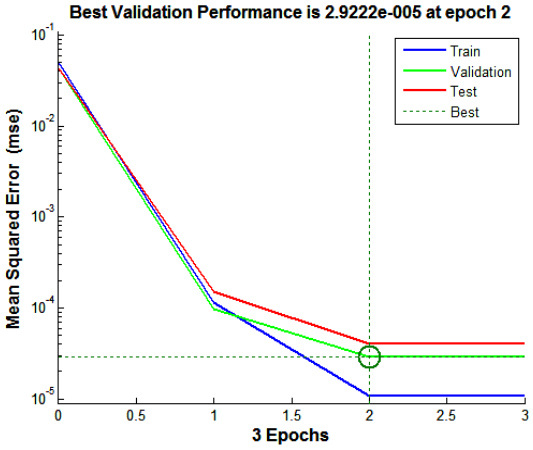

Figure 4. Mean Square Error (MSE) variations during training steps for training, validation and testing for a neural network with 1 hidden layer and 37 neurons (acidity)

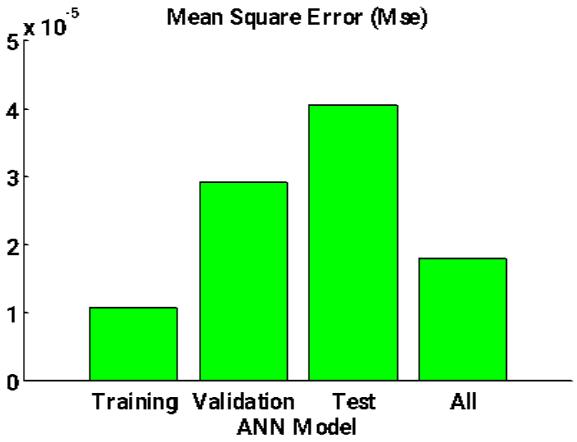

Figure 5. Mean of squares of the acidity neural network

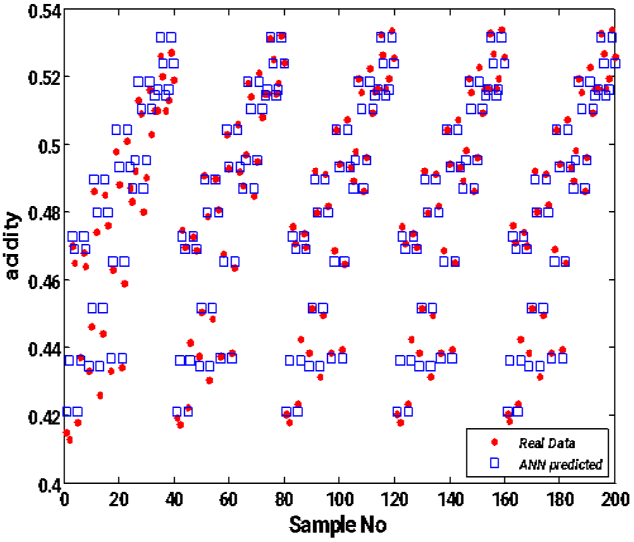

Figure 6. The results of the predicted acidity versus experimental data with number of samples, artificial neural network with 1 hidden layers and 31 neurons

6- General conclusion

The results of this study showed that the use of different concentrations of fennel seed extract and mountain kakuti significantly (p<0.05) led to a decrease in pH and an increase in acidity during the storage period. Increasing the storage time of different treatments significantly (p<0.05) led to an increase in the content of dissolved solids (Brix). treatment which contained higher percentages of plant extracts, the increase rate of their soluble substances significantly (p<0.05) was lower than other samples. The sensory evaluation of different treatments showed that there was no significant difference between the control treatment and the treatments containing 0.5% and 1% of different extracts in terms of color and appearance.p>0.05).

The taste of the treatments that contained 2 and 3% of fennel extract was considered unfavorable by the evaluators, but the treatments that contained high percentages of fennel seed extract (2 and 3%) had a significantly better taste at the end of the storage period than other treatments. They were. Using 2 and 3% of fennel seed extract

significantly (p<0.05) cause to preserve the pleasant smell of tomato paste

Ferengi was kept until the end of the period. Sensory evaluation in terms of consistency showed that treatments with low percentage of extract had better consistency. Finally, the laboratory data of acidity using neural networks with two input parameters achieved acceptable results, so that the values of correlation coefficient and mean square error for training, validation and test data are equal to 99482/ 0, 0.99127, 0.98664 and 0.00001, 0.00003 and 0.00004.

7- Resources

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مقاله علمی_پژوهشی

بررسی خصوصیات فیزیکو شیمیایی و حسی رب گوجه‌فرنگی با استفاده از عصاره دانه رازیانه و گیاه کاکوتی کوهی و پیش‌بینی نتایج حاصله با استفاده از شبکه عصبی مصنوعی

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چکیده

این مطالعه با هدف تولید رب گوجه‌فرنگی با استفاده از نگه‌دارنده‌های طبیعی به‌عنوان جایگزین نگه‌دارنده‌های شیمیایی انجام شد. عصاره دانه رازیانه (Foeniculum vulgare Mill) و کاکوتی کوهی (Ziziphora clinopodioides Lam.) به‌عنوان نگه‌دارنده طبیعی مورداستفاده قرار گرفتند. خصوصیات فیزیکوشیمیایی رب گوجه‌فرنگی مثل pH، اسیدیته و مواد جامد محلول کل (بریکس) در طول ۵ هفته نگهداری در دمای ۴ درجه سلسیوس اندازه‌گیری شدند. خصوصیات حسی رب گوجه‌فرنگی با کمک ارزیاب‌های حسی آموزش دیده و آموزش ندیده با استفاده از مقیاس هدونیک ۵ نقطه‌ای مورد ارزیابی قرار گرفت.برای پیش‌بینی داده‌ها از شبکه عصبی مصنوعی با توپولوژی۱-۳۷-۲ با تعداد دو ورودی شامل طول دوره نگهداری و غلظت‌های مختلف عصاره دانه رازیانه و کاکوتی کوهی و اسیدیته به عنوان پارامتر هدف در نظر گرفته شد. نتایج نشان داد به‌کارگیری غلظت‌های مختلف عصاره دانه رازیانه و کاکوتی کوهی به طور معنی‌داری ($p<0.05$) باعث کاهش pH و افزایش اسیدیته رب‌های گوجه‌فرنگی شدند. افزایش سطح عصاره‌ها در نمونه‌های رب گوجه‌فرنگی به طور معنی‌داری ($p<0.05$) منجر به افزایش بریکس در طول دوره نگهداری شدند. ارزیابی حسی نشان داد که از لحاظ رنگ، شکل ظاهری و قوام تیمارهایی که حاوی غلظت‌های پایین عصاره بودند (۰/۵ و ۱ درصد از هر دو عصاره) امتیاز بیشتری را کسب کردند. از لحاظ طعم و بو تیمارهای ۳ و ۴ (به ترتیب حاوی ۲ و ۳ درصد عصاره دانه رازیانه) بالاترین امتیاز را داشتند. به طور کلی می‌توان نتیجه گرفت که استفاده از ۲ یا ۳ درصد عصاره دانه رازیانه به عنوان نگهدارنده طبیعی در رب گوجه فرنگی منجر به خصوصیات فیزیکوشیمیایی و حسی مطلوب می‌شوند. نتایج پیش بینی اسیدیته نشان داد که ضریب همبستگی و میانگین مربعات خطا برای داده های کل برابر با ۰/۹۹۲۳۲ و ۰/۰۰۰۰۲ می باشد که نشان از یک پیش بینی موفق است.