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Improving quality and shelf life of Taftoon bread by using plum puree and concentrate

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ABSTRACT- Considering health and economic issues, today, consumers have become more concerned with foods which contain natural ingredients. Hence, in this study, the effects of plum concentrate and puree which were incorporated into the Taftoon bread formulation at different levels on the rheological, baking properties and shelf life of bread were evaluated. Results showed that addition of plum concentrate and puree improved the quality and shelf life of Taftoon bread. Plum puree was effective in improving dough development time, mixing tolerance index and dough softening while concentrate affected stability and water absorption. Bread containing 4% plums puree had the lowest hardness compared with other samples. Image processing analyses showed that both concentrate and puree improved browning in Taftoon bread. Therefore, plum concentrate and puree can be used as a humectant to improve the quality and shelf life of Taftoon bread.

INTRODUCTION

Flat bread is one of the oldest and most famous types of bread in the world, and most consumed forms of bread in Iran. This bread is prepared with specific properties and under specific conditions, of which the fermentation process is of special importance (Qaroni et al., 1990). Consumer demand is toward consumption of high quality fresh bread. However, this product has a short shelf life. Therefore, application of some additives is necessary to improve dough machinability, crumb texture and freshness of the product during storage. Certain chemical substances are nowadays used as bread improvers, which are harmful to human health in some cases (e.g., cancer, digestive and heart diseases) and the importation of the majority of this substances causes economic drawbacks. On the other hand, consumption of functional foods, and other health foods, has been on the rise in recent years as consumers' focus has become more health oriented. Consumers have become more concerned with natural foods, and foods that contain only natural ingredients. Most consumers also desire natural additives more than their chemical counterparts due to the rising concern that diseases such as cancer may be caused by unnatural ingredients (Sara and Davis, 2004). These natural additives' reactions should be similar to those of their chemical counterparts and they should be able to produce the required properties in the final product, and at the same time, be economic and prevent currency exodus. Identification and introduction of these additives will be a huge step in the bread industry.

Recent research on plum with respect to its unique composition has resulted in the presentation of this product as a natural additive and preservative for various foodstuffs even in space voyages. Plum is generally recognized as a source of fibre and is less well-known as a natural source full of sorbitol, malic acid, and natural antioxidants which act as deterrent against pathogenic organisms. Therefore, plum can act in such a way to increase the quality, lengthen the shelf life, enhance the nutritional property, and prevent the growth of microbes in the product. Its phenol content produces antioxidant properties, sorbitol and fibre content produce natural humectants, shortening, emulsifiers, and finally the resultant quality and shelf life, and malic acid possesses flavouring properties (Stacewicz et al., 2001).

Plum prevents mould growth and preserves moisture in bakery products and therefore increases shelf life (Castaldi et al., 2003). The use of powdered plum is recommended for the reduction of and eventual substitution of fat in bread products. It is such that addition of powdered plum equivalent to 5% of the weight of flour used can reduce fat usage up to 50% (Kreuzer, 2001). Dried plums have been recognized as a unique product that can replace emulsifiers, caramel color, and calcium propionate in bakery products (Sanders, 1991).

Successful applications of the concentrates have included a range of bakery products. In many cases, the properties derived from prunes and raisins are used to replace other additives, it has been theorized that prune and raisin concentrate might inhibit mould development in bakery products due to its high malic acid content as well as traces of benzoic and salicylic acids. In addition, the concentrate has been used as a natural sweetener, colorant, and humectants in bakery products (Sanders, 1991; Sabanis et al., 2009). The research on the treatment of bread by raisin concentrate indicated that an addition of 3% concentrate improves bread volume, color, and baking; as well as increasing its shelf life as it enhances moisture absorption (Decock and Cappelle, 2005).

The aim of this work was to investigate the effect of plum puree and concentrate (as natural humectants) for improving dough rheology and enhancing Taftoon bread quality and shelf life.

MATERIALS AND METHODS

Materials

Commercial wheat flour with 85% extraction rate was obtained from Razavi Milling Factory in Mashad and preserved at ambient temperature. All of the bread recipes also contained active dry yeast (*Saccharomyces cerevisiae*) that was procured from Razavi Co., Mashad, Iran. Other ingredients (none-Iodized salt, sugar, cooking oil) were purchased from local market. The plums used were the Red *Santarosae* variety, obtained from the agricultural and natural resources research centre in Khorasan Razavi.

Preparation of the Plum puree and Concentrate

The plum samples were formed into concentrate with 28% brix and puree with 32% brix following the manufacture method reported by Barrett et al., (2004).

Flour Analysis

Moisture (44–16 A), ash (08–07), fat (30–10), wet gluten (38–11) and falling number (56–81) were determined according to AACC-approved methods (AACC 2000). Flour protein was tested using a Kjeltec auto protein tester (model 1030, Tecator Co., Hoeganaes, Sweden).

Farinograph Study

The effects of plum concentrate and puree on dough rheology were analyzed using farinograph (Duisburg, Germany) following the AACC method (2000) NO 54-21. The parameters tested for analysis were: water absorption, dough development time (DDT), stability, mixing tolerance index (MTI), and valorimeter value.

Taftoon Bread Preparation

All ingredients, 100% wheat flour, 1% dry yeast, 2% salt, 1% sugar, 1% vegetable oil, and water (based on the Farinograph absorption) were mixed for 10 minutes in the bowl of a spiral mixer. Plum concentrate and puree were added to the flour at three levels (2%, 4% and 6%) and (4%, 6% and 8%) w/w flour basis, respectively. The first fermentation was performed at ambient temperature (25°C) for 30 minutes and the dough was then divided into 250g pieces and patted. Next, the rounded dough was placed at ambient temperature for the intermediate fermentation for 10 minutes. Following this stage and forming, the dough was then proofed at 45°C and 85% moisture for 15 minutes for its final fermentation. The dough was finally baked in a rotary oven (the Italian ZuccihelliForni model) at 360°C for 13 minutes. After cooling, bread samples were packed in polyethylene bags and stored at room temperature (25 °C).

Texture Measurement

Changes in the texture of dough and Taftoon bread were measured by using the penetration test. A QTS texture analyzer (CNS Farnell, Hertfordshire, UK) was used to measure the force required for penetration of a round-bottom (2.5 cm diameter×1.8 cm height) probe at a velocity of 30 mm/min and descended 30 mm (a sufficient distance to pass through the slice of 10×10 cm of bread) into the bread. Trigger value 0.05 N. Three replicates from three different sets of baking were analysed (Bollain and Collar, 2004).

Color Analysis

The color was analyzed using the L*, a*, and b* indicators which are used to determine bread quality. The L* indicator illustrates the brightness of the bread and varies between 0 and 100 indicating pure black to pure white. The a* indicator is used to measure the proximity of the sample color to green and red, and the b* indicator measures the proximity to yellow and blue. These last two indicators range from -120 to 120. A slice of bread was cut with a serrated knife and for each treatment, three samples were scanned with desktop flatbed scanner (HP, Scanjet G3010; at Optical Resolution of 4800 dpi×9600 dpi) and the images were saved as BMP format. To study the effect of processing parameters on colour components of bread, the RGB colour space images were converted to L*a* b* space (Fathi et al., 2011).

Statistical Analysis

The data obtained were statistically analysed using the 16th edition of the SPSS software in the form of a completely random plan with 3 replications. The means were compared by means of a Duncan Test at 5% level ($P<0.05$) and charts were plotted by EXCEL.

RESULTS AND DISCUSSION

Chemical Properties of Flour

The chemical properties of the flour used in this research can be seen in Table 1. They indicated that flour used in this study had medium to high quality which was suited to Iranian flat breads.

Farinograph Parameters

Water Absorption

The analysis results indicated that the addition of plum puree and concentrate resulted in a significant increase in water absorption in comparison with the control sample ($P<0.05$). Figure 1 indicated that as the amount of concentrate increased from 4 to 8 percent, the percentage of water absorption also rose. Similar results were observed in sample treated with puree, though the concentrate was shown to be more effective.

Table 1. Chemical properties of the flour

Contents	Amount (%)
Moisture	10.52
Protein	10.8
Fat	1.76
Ash	0.79
Wet Gluten	26.7

Other research results show that water absorption level is influenced by fibre content (Cauvin and Young, 2007). As plum is a rich source of fibre, it can, therefore, be concluded that the reason for the increase in the absorption of water following the addition of plum can be related to its high fibre content (Sanders, 1991). Plum is unique among natural humectants due to the combination of fibre (half of which is soluble), sorbitol and other reducing sugars (glucose and fructose) that retain and then hold moisture (Castaldi et al., 2003). As the plum puree and concentrate are not readily fermentable, unlike honey or high fructose corn syrup, it remains largely as a humectant in yeast-leavened baked goods (Sanders,1991). Bread containing 8% of plum concentrate and the control had the highest and lowest water absorption values, respectively.

Dough Development Time

Dough development time (DDT) indicates the time required for the dough development or time necessary to reach 500 BU of dough consistency (DDT) which was modified in a different manner by each treatment. In the process of development of a bread dough, physical properties of the dough particularly its water absorption and ability to retain the co_2 gas were increased. Therefore, if DDT expands, the bread texture, shelf life and appearance will be improved. Results indicated that treatment with up to 6% concentrate leads to an increase in this time, while at the 8% level, a significant reduction was observed. Treatment with plum puree at 2% and 4% levels resulted in increasing this parameter, but in the case of the concentrate, as the viscosity of the dough increased, development time decreased (Fig. 2). The increase in the DDT at low levels of concentrate and puree can be related to their moisture absorbent property in that as the existing water in the dough is reduced, the kneading time increases. However, the effect has been attributed to the hydroxyl groups in the humectants structure of plum which allow more water interactions through hydrogen bonding and high content of dietary fibre, both soluble and insoluble that increased DDT. At higher percentages, the silicosis properties of the plum contents such as sorbitol dominate and reduce the dough development time (Sanders, 1991).

Dough Stability

The stability value was an indication of flour strength, with higher values suggesting stronger dough. As indicated in Fig. 3, addition of plum concentrate resulted in the significant increase in dough stability and its subsequent strengthening in comparison to the control sample. No significant difference was observed between the 6% and 8% levels ($P>0.05$). Treatment with plum puree also increased dough stability when compared with the control sample, though it was less effective than the concentrate. The dough proved most stable by treatment with plum puree at the 4% level (Fig. 3). The increase in dough stability can be related to the humectant content in plum. Suhendro et al. (1995) achieved similar results when testing humectant effect on tortilla dough. Dogaru et al. (2011) reached similar conclusions in research on the effects of plum and apricot on rheological properties of the dough.

Mixing Tolerance Index (MTI)

Mixing tolerance index is used by bakers to determine the extent to which dough will soften over a period of mixing. Mixing tolerance index (degree of softening) is measured as the distance between the entrance of the curve at the end of analysis time and the central line which passes through the maximum of the curve.

Using plum concentrate and puree reduced the mixing tolerance index which showed that dough stability increased. The farinograph parameter of dough stability increased, whereas the mixing tolerance index decreased with increasing amounts of additives.

No significant difference ($P<0.05$) was observed in the MTI, between the concentrate and the puree (Fig. 4).

Moisture Content of Bread

The treatment of dough with plum in concentrate and puree form resulted in an increase in the bread moisture when compared with the control sample (Fig. 5). The highest amount of moisture was measured at the 6% level of plum puree, while for the concentrate, it was determined to be at the 8% level. The reason for this increase can be attributed to the humectant property of the plum which causes the retention and preservation of moisture in the bread (Dogaru et al., 2011). It was also stated by McCarthy et al. (2005) that the hydrophilic humectant (the existence of sorbitol in the plum) chemical compounds are able to react with water and cause the reduction of its distribution and maintain its retention within the system, which will be influential in the increase in the absorption of water by the dough and retention of the moisture within the final product during the baking and preservation process.

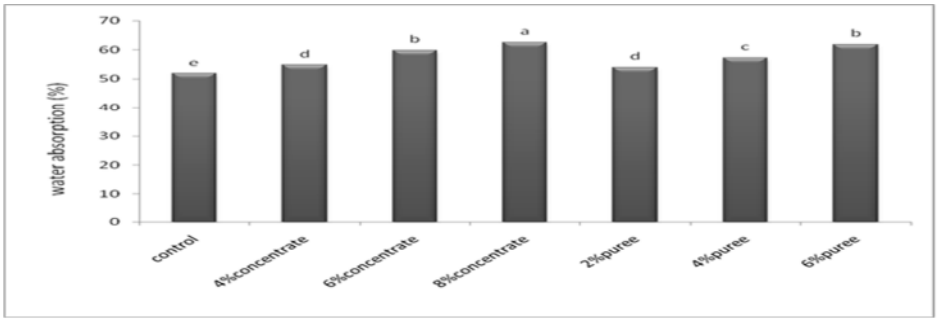

Fig.1. The effects of plum puree and concentrate on the water absorption of dough

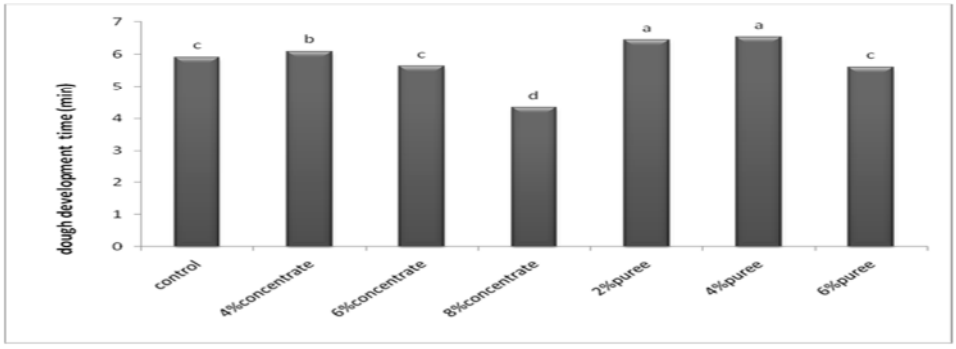

Fig. 2. The effect of plum purees and concentrates on cough development time

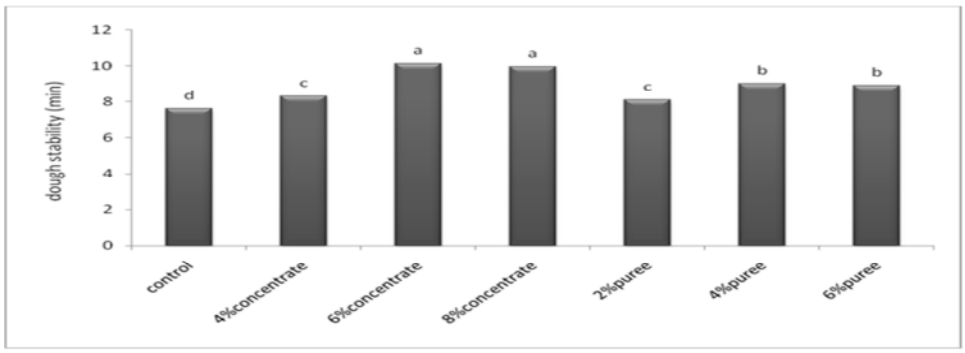

Fig. 3. The effect of plum puree and concentrate on dough Stability

Hardness of the Bread

The resistance of the bread crumb to deformation is the textural attribute referred to as firmness and it is an important factor in bakery products since it is strongly correlated with consumers' perception of bread freshness (Ahlborn et al., 2005). The results indicated that treatment containing plum concentrate and puree resulted in the significant reduction of the hardness of bread during shelf life. As indicated in Fig. 6, the least level of hardness is attributed to the 4% puree level. Plum puree was more effective than plum concentrate in reducing the bread hardness. The humectants present in plum increase the ability to retain water and reduce firmness, which has previously been approved by He and Hoseney (1990). Plum puree has the ability to hold more water in the dough, as it contains fibre and simple sugars, educing sugar, fructose and glucose, and dietary fibre works with sorbitol to provide further humectancy. Comparing the result of bread hardness at 2 hours and 3 and 7 days after baking showed the hardness of bread did not increase at storage time, which means the salting of bread was retarded and hence increased the shelf life of bread. The antistaling effect of plum may be related to its ability to retain the water and release it during shelf life that prevents bread hardness. The staleness and hardness of the bread involves a complex process in which various elements such as retro gradation of amylose, the moisture level reduction, and the distribution of moisture within the amorphous and crystallized regions are involved (Ahlborn et al., 2005). The polyols' highly hygroscopic nature has been implicated in its ability to retard staling by forming an entangled amorphous matrix around the starch molecules via disrupting the hydrogen bond between

neighbouring protein strands and via reducing interchange attractive forces. Such a matrix may also contribute to the increased chain mobility, flexibility and homogeneity of the water distribution in the sample. The inverse relationship between the firmness and the moisture content has already been reported (He and Hoseney, 1990). Smaller loaves (as those with sucrose) were denser and had tightly packed crumb structure, resulting in higher crumb firmness values. Similar findings were obtained by Gallagher et al. (2003) in gluten free bread. Plum concentrate and puree are unique in their naturally high sorbitol and polyols content. Sorbitol is an effective humectant, and thus helps to keep bakery products soft and moist over an extended shelf life. Reducing sugar, fructose and glucose, and dietary fibre works with sorbitol to provide further humectancy. The antistaling effect of plum concentrate and puree may be related to their ability to retain the water and influence polyols on the retro gradation rate of starch (Pourfarzad et al., 2009, Sabanis et al., 2009). Similar results for the reduction of the bread hardness when treated with plum puree were indicated in other research (Suhendro et al., 1995, Dogaru et al., 2011).

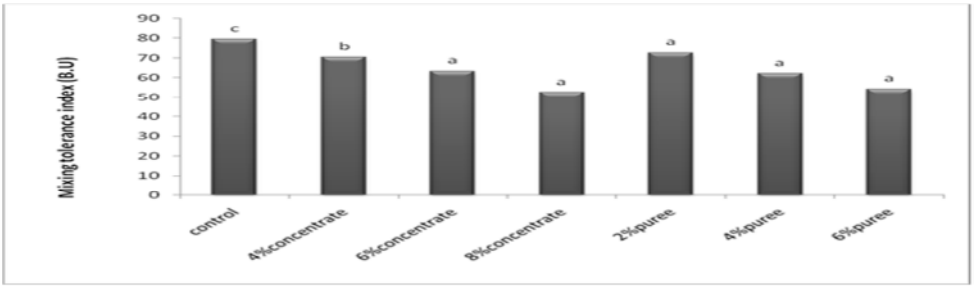

Fig. 4. The effect of plum puree and concentrate on mixing tolerance index

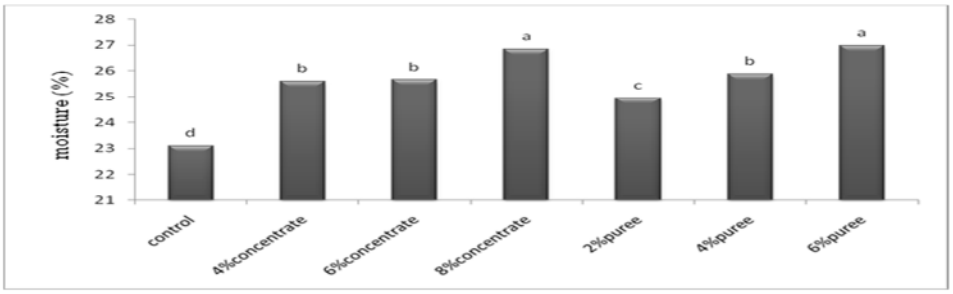

Fig. 5. The effect of plum Puree and concentrate on bread moisture

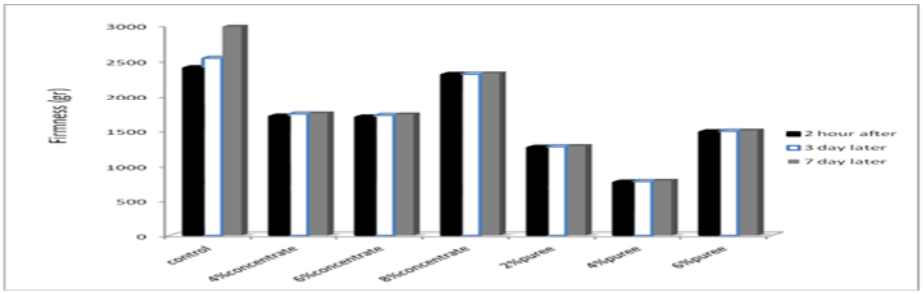

Fig. 6. The effect of plum puree and concentrates on the bread hardness

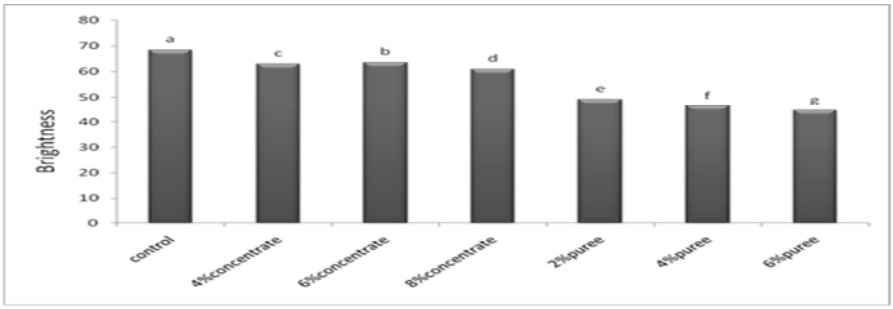

Fig. 7. The effect of plum puree and concentrate on L*

Bread Crust Color Analysis

Among all physical properties of foods, color is the most important optical feature in the discernment of product quality and has a high influence on consumer preference (Ribotta et al., 2010).

Investigations of the addition of plum puree and concentrates indicated that the treatment with plum caused a reduction in L*of the bread when compared with the control sample. The puree proved to be more effective than the concentrate. Increasing the level of concentrate made more decrease in L*of bread crust. Both the puree and the concentrate contain a high level of sugar which react with the amino acid chains of the proteins (Maillard reactions). Maillard reaction takes place during baking between reducing sugar and amino acid chains of proteins (Raidi and Klein, 1983). Another chemical reaction that causes browning of baked products during baking is caramelization which depends on direct heat degradation of sugar. It should be noted that in Taftoon Bread slight browning is desirable.

The results from the research on the effect of plum on the improvement of the bread produced indicated that treatment with plum leads to browning in the bread. It was also suggested that plum can be used as a substitute for caramel colors in bakery products (Sanders, 1991).

The b* value expresses the proximity of the color to the colors blue and yellow, while a*illustrates proximity to green and red and ranges from -120 to +120. The higher value of b* in Tafton bread is more desirable. As indicated in Table 2, addition of both the puree and the concentrate resulted in the increase in the value of b* when compared to the control sample and the highest value was observed at the 8% concentrate level. As the level of plum concentrate and puree increased, the greater value of b* in bread crust was observed. However, the concentrate was more effective than the puree.

Table 2. The Effect of Plum Puree and Concentrate on the a* and b*

	The Crust Colour	
	a^*	b^*
Samples		
Control	4.00 a	58.37 a
4% Concentrate	8.44 b	62.97 d
6% Concentrate	9.85 c	65.55 e
8% Concentrate	10.09 c	67.81 f
2% Puree	9.63 c	60.11 b
4% Puree	11.01 d	61.99 c
6% Puree	12.65 e	62.59 d

The lesser value of a* is more desirable in flat Bread. Investigation of the treatment with puree and concentrate plum indicated that concentrate at the 4% level resulted in a reduction of a* value. The best treatment was achieved at the 4% level of concentrate. The increase in the a* value may be related to the greater number of color pigments and phenol content of the concentrate as opposed to the puree. Pureeing the plum causes the increase in the concentration of the solid substances and its other compounds which, in turn, results in the further intensity of the color of the bread. This increase in the intensity can also be related to the existence of high sugar content in the puree and the concentrate in accordance with the mechanism explained in the previous section.

CONCLUSIONS

Although the nutritional properties of plum puree and concentrate are widely recognized, little work has actually been performed to elucidate their functional properties in bakery products.

The timing is right for researchers to focus on the use of natural products to replace chemical additives. This study indicated that the use of plum puree and concentrate in dough products as a natural substitute for sorbitol, chemical colorant, leavening and preservative agents, gave breads with a higher volume, appealing brown color, and increased softness and shelf life.

Thus, prune and raisin concentrate can effectively be used in place of sorbitol or other sugar alcohols while maintaining a "natural" formulation. Additionally, they serve as a natural preservative in yeast-leavened baked products. With their other attributes of natural color, dough strengthening, flavor enhancement, sweetening, and humectancy, they can be considered a multi-purpose natural food ingredient.

Treatment by plum puree and concentrate resulted in the enhancement of qualitative and rheological properties of the dough and increased the shelf life of bread. Puree was most effective in mixing tolerance index and stability while the concentrate more positively influenced the dough development time and water absorption. Treatment with both the puree and the concentrate led to the rise in bread moisture though the puree proved more effective. The best sample was obtained from treatment at the 4% level of plum puree. Treatment with plum did not change the hardness of bread at storage time to 7 days; hence, it increased the shelf life of the bread. The puree was more effective in the reduction of the hardness and increase in the shelf life of the bread with the best result being obtained at the 4% puree level. Color analysis indicated that while treatment with plum led to the enhancement of all color components except brightness, the concentrate was more effective than puree. Therefore, it can be concluded that plum can be used as a natural additive in bakery products because besides improving rheological, qualitative, and sensory qualities, it can increase the shelf life and their nutritional value.

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بهبود زمان ماندگاری و کیفیت نان تافتون با استفاده از پوره و کنسانتره آلو

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ویژگی های رئولوژیک
زمان ماندگاری

چکیده- استفاده از ترکیبات طبیعی بجای ترکیبات شیمیایی در صنعت پخت از نظر اقتصادی و سلامتی حائز اهمیت است. از اینرو، در این پژوهش اثر استفاده از کنسا نتره آلو در سه سطح (۴،۶ و ۸٪) و پوره آلو در سه سطح (۲،۴ و ۶٪) بعنوان یک افزودنی طبیعی بر بهبود ویژگی های کیفی، رئولوژیک و خمیر و نان تافتون بررسی شد. نتایج نشان داد که افزودن کنسانتره و پوره آلو سبب بهبود کیفیت و زمان ماندگاری نان تافتون شد. تاثیر پوره آلو بر بهبود ویژگی های زمان گسترش، شاخص تحمل و درجه سست شدن خمیر و اثر کنسانتره بر پایداری و جذب تاثیر داشت. نان حاوی ۴٪ پوره آلو کمترین میزان سفتی را داشت. نتایج آنالیز رنگ نشان داد که پوره و کنسانتره سبب بهبود رنگ قهوه ای مطلوب در نان تافتون شدند. بنایراین پوره وکنسانتره آلو می توانند بعنوان یک هموکتانت، بهبود دهنده خواص کیفی و نگهدارنده در صنایع پخت معرفی شوند.