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Abstract

Functional foods have positive effects on human health. The aim of this study was to produce a new product to increase the tendency to consume jujube and taking advantages of its medicinal properties by adding it into bread as a staple food, which provides a significant part of energy, protein, fibre, minerals and vitamins. For this purpose, the dried jujube fruits were mixed with water and heated using a direct flame to reach Brix 15. Then pits were removed from the pulps using rotary operator and then the Brix increased to 65. In order to produce functional bread, three treatments (3, 6 and 9% jujube extract) were evaluated at a ratio of 1:2. According to the physicochemical tests, the 3 and 6% treatments were found to be the best treatments. In addition, the 6% treatment was chosen as the best bread in terms of sensory properties by panellists.

Keywords : Bread, Jujube, Functional food and Physiochemical properties

Introduction

In today’s world, consumers’ desire for foods that promote health and wellness has increased. In this regard, functional foods as an important group played a significant role and have an important place among those people who care about their health. Historically, the consumption of cereals first began in the form of roasted grains in human communities, and then due to difficulties in digestion and absorption, the man tried to separate some part of the hull from the seeds by crushing the seeds to powder form and then mixed them with water to obtain dough and cooked the dough on a baking stone over an open fire, a process by which primary bread making technology formed.

Bread is the main and essential food of many people in the world, providing energy, protein and mineral as well as and B group vitamins. In Iran, about 60 - 65% of protein and calories and 2-3 g of minerals and most of the daily salt intake is supplied with bread (Rajabzadeh, 1996). The knowledge and technology of functional foods were first introduced in Japan since 1980. At that time, the Japanese government decided to control diseases through promoting the production and consumption of certain foods among the population, which in turn reduce costs of health-care. Therefore, functional food industries have been established and started to add or condensate beneficial compounds and eliminate inert or harmful substances.
from the food products. In a short period of time, the market for such products has grown considerably. The Food and Drug Administration (FDA) describes the benefits of these foods based on the effect they have on the human health, body function and diseases after they are consumed. It is noteworthy that the FDA does not recognize this group of foods as "Food Functional, rather these products are known as specific foods that are generally defined as traditional foods, nutritional supplements and dietary supplements or formulated foods. Functional foods are foods that not only provide daily calorie and protein requirement but also have a positive effect on human health. In addition, functional foods play an important role in reducing the risk of disease and improving life quality. The potential of some plant-derived foods in reducing the risk of chronic diseases, at least in case of secondary metabolites, has been clarified in a wide range of biological investigations (Hesler, 2009). The combination of jujube extracts with bread has a great potential to be introduced as a functional food. On the other hand, adding jujube in different food products create innovation to increase products’ value added. The freshly harvested or dried jujube fruits are often used for medicinal purposes; however, it is used as a snack or dried fruit along with nuts. Jujube fruit is rich in vitamin C (Ghoos, 2009) and contains five times more phosphorus, two times more potassium and ten times more ascorbic acid in comparison to apple. Previous studies have shown that jujube fruits contain alkaloids, flavonoids and terpenoids. Moreover, the jujube fruits are rich in fatty acids, beta-carotene, alpha tocopherol and seven phenolic compounds including, catechin, caffeic acid, epicatechin, ferulic acid, rutin, p-hydroxybenzoic acid and chlorogenic acid (Ashrafi et al., 2010). In a study, a processing technology using the baking method was used to extract jujube enzymes (Wang et al., 2012). Jujube nutrients and bioactive substance were extracted using pre-baking and pectinase enzyme technology. The extraction desirable parameters included: total pectinase: 0.2%, extraction temperature 50°C, extraction duration: 4 h and ratio: 1:3. The aim of this study was to produce a new product to increase the desire to consume jujube by adding it to bread as a staple food. The product will provide the consumers with jujube nutrition and health benefits. Moreover, the product creates a diversity in cereal products.

**Material and methods**

Dried jujube fruits and refined wheat flour (81% extraction degree) were purchased from a local store and a manufacturer in Mashhad, respectively. White sugar (Bargahe Neyshabour Company, Iran), mixed vegetable oil (soybean, canola and sunflower) (Rana, Alia Golestan Company, Iran) and bakery yeast (Saccharomyces cerevisiae) (Fariman Company) and flour improver (Daneshgaran Novin Delsa Company) were also purchased from a local supermarket.

**Jujube extract preparation**

Jujube fruits were properly washed and then scratches have been created on the fruits. Afterwards, fruits were heated into the water (1 : 4 ratios) for 3 h at 80±5. At degrees Brix of 25, the mixture was drained using a plastic colander. Pits and pulps were separated. In order to increase extraction efficiency, the mixture was heated again. Then they obtained extract was filtered using filter paper and a vacuum pump. The extract was concentrated using Rotary evaporator (Heidolph4003, Germany) at 45°C and 72 mbar vacuum for 2 h.

**Dough and bread preparation**

Refined wheat flour (100%), oil (2.5%), salt (1%), sugar (1%), yeast (1%) and flour improver (0.5%) were combined together in a large bowl and then jujube extract was added according to the treatments
Water was added and mixed for 15 min. The dough was covered with a damp towel and set aside for 15 min and then divided into 120 g parts. The dough was left to rise for 5 more minutes. After that, the dough was spread using a sheeter and put into an oven for 45 min at 45° C to be steamed and then baked for 20 min at 200°C.

**Bread moisture percentage**

Bread moisture percentage was measured as per AACC 2000-code 44-46 standard. For this purpose bread samples tested 1 and 2 days after baking with 2 h intervals.

**Bread water activity**

Bread water activity was measured using a water activity meter (Novasina, MS1, England) in the same size crushed samples with 2, 24 and 48 h intervals after baking.

**Bread specific volume**

Bread specific volume was determined according to AACC 2000-code 72-10 standard. For this purpose bread samples (1.5 ×1.5 cm) tested 1 and 2 days after baking with 2 h intervals.

**Bread texture**

Bread texture was determined using a texture analyzer (QTS 25, England) 3 and 6 (change to 1 and 2 days) days after baking with 2 h intervals (Gargari et al., 2005). Slices of 2.5 cm thickness were compressed with a probe (2cm diameter and 2.3 cm height) at a crosshead speed of 1 mm/s. The resulting peak force of compression was reported as bread firmness.

**Bread colour**

The crust color was determined 1 and 2 days after baking with 2 h intervals according to measures of lightness (L), ranging from 0 (black) to 100 (white), and the chromatic components, a* and b*, which range from green to red and blue to yellow, respectively, on a scale of −120 to +120. For this purpose, 5×5 cm bread samples were scanned (HP Scanjet G 3010 300 dpi) and then analyzed using Image J software in LAB and Plugins mode (Majzoobi et al., 2010).

**Bread porosity**

Bread porosity was determined 1 and 2 days after baking with 2 h intervals. For this purpose, 5×5 cm bread samples were scanned (HP Scanjet G 3010 300 dpi) and analyzed in the Image J software. The colour images were first gray scaled and then threshold using the iso-data algorithm. The porosity was measured from the ratio of white to the total numbers of pixels (Shogren et al., 1973).

**Bread sensory analysis**

Bread sensory analysis was performed according to (Rajabzadeh, 1996) recommended method. The sensory analysis was conducted with a group of 15 trained panellists. Panelists were asked to assess the bread’s quality factors, including bread shape (asymmetric, rupture or any hole), surface characteristics (burning, color, uneven or odd surface), underneath characteristics (burning, color, uneven or odd surface), porosity (density and compaction), firmness (soft or crispy), chewing properties (dry or moist, being doughy or sticky), taste, aroma (strong smell, row or sourness smell or natural smell), to rate samples from 0 to 5 (0 unacceptable, 5 very acceptable). It should be noted that the characteristics examined in the evaluation are not equally effective, therefore, considering the features and reviews, each of the attributes is scored called rating coefficient. Bread total score was calculated according to the following formula.

\[
Q = \frac{\sum(P \times G)}{\Sigma P}
\]

Where Q: total score; P: rating coefficient and G assessing coefficient.
The results were analyzed using MSTAT-C 1.42. The experimental design was a factorial experiment with three replicates and one way ANOVA was used to analyze the data. Comparison of means was performed using Duncan’s multiple range test at 0.01 probability level. The graphs were generated using Microsoft Office Excel.

Results and discussion

Water activity

The results indicated that the effect of jujube extract was significant on bread’s water activity so that water activity decreased with increasing jujube extract concentration. Analysis of variance on bread characteristics shown in (Table - 1). Available water content, which indicates water activity decreases with increasing soluble solids and sugar content on account of jujube extract (Fig.- 1). Application of food with 15 - 35% moisture and 0.6-0.8 water activity reduce water activity without losing water (Fatemi, 2009). The product loss water over time, but not soluble solids (Fig.- 2). Therefore, reduction in water activity over the time makes sense. Similar results were found by (Gharavi, 2016) who studied the effect of jujube extract on bread, water activity and found that water activity decreases with increasing jujube extract concentration (Fig.- 1).

Specific volume

The effect of jujube extract was significant in a specific volume so that specific volume decreased with the increasing jujube extract application. Considering the specific volume is the system's volume per unit of mass, Brix (soluble solids) increases with increasing extract concentration and the higher the amount of extract used, the higher mass (at the same volume) obtained. There is an inverse relationship between mass and volume, therefore, increase in mass is parallel with a reduction in a specific volume (Fig.- 3). Passage
of time also reduces the moisture content while the soluble solids remain in the sample. Time reduces the specific volume in the same way as it increases mass (Fig.- 4). In another study carried out by (Qazi et al., 2003) on physicochemical properties of jujube cake, similar results were found so that specific volume decreased with increased jujube extract and passing time. It should be noted that the difference in specific volume of jujube bread after 3 days was much less than the difference between the specific volumes of the cake.

**Firmness**

The results revealed that the effect of jujube extract was significant on bread firmness so that increase in extract could reduce bread firmness. Similar results were obtained (Petitot et al., 2010) who studied the effect of date pulp on Sangak bread. Application of jujube extract improves bread characteristics such as dough water retention and absorption capacity, which lead to softer bread and

![Fig.-5. The effect of time on bread firmness](image)

![Fig.-6. The effect of time on bread pH](image)

**Table - 1. Analysis of variance on bread characteristics**

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>Water activity</th>
<th>Specific volume</th>
<th>Firmness</th>
<th>pH</th>
<th>Porosity</th>
<th>Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jujube extract</td>
<td>3</td>
<td>0.02**</td>
<td>5.79**</td>
<td>26071908.96**</td>
<td>1.46**</td>
<td>782.22**</td>
<td>34.78**</td>
</tr>
<tr>
<td>Time after baking</td>
<td>2</td>
<td>0.01**</td>
<td>2.59**</td>
<td>9378547.86**</td>
<td>0.07**</td>
<td>323.01**</td>
<td>50.73**</td>
</tr>
<tr>
<td>Interaction</td>
<td>6</td>
<td>0.0001ns</td>
<td>0.36ns</td>
<td>226614.66ns</td>
<td>0.006ns</td>
<td>3.19ns</td>
<td>0.81ns</td>
</tr>
<tr>
<td>Error</td>
<td>24</td>
<td>0.0002</td>
<td>0.45</td>
<td>196542.28</td>
<td>0.01</td>
<td>4.11</td>
<td>0.56</td>
</tr>
<tr>
<td>C.V (%)</td>
<td>-</td>
<td>2.03</td>
<td>14.28</td>
<td>6.95</td>
<td>1.79</td>
<td>6.13</td>
<td>3.19</td>
</tr>
</tbody>
</table>

**Significant at 0.01% probability level and ns no significant**
also slow down staling process. Passage of time causes loss of moisture in bread, which increases the stiffness of the product (Fig.-5). In a study (Alviano et al., 2009), the Russian olive bread firmness was at the maximum value 5 days after baking, similar to what we found here in jujube bread. In another study, the effect of apple fibre was studied on Barbari bread (A traditional flatbread in Iran and Turkey (Turkish bread)) firmness (Pohjanheimo et al., 2006) who found that bread firmness increases over the time.

**Bread pH**

The results indicated that bread pH decreases with the increasing jujube extract application. Moreover, the effect of time was significant on bread pH so that passage of time led to a significant reduction in bread pH. It has been reported that Jujube extract pH is about 5.08 (Cauvain, 2001). Therefore the application of jujube extract into the dough reduce its pH. Passage of time slightly affected bread pH and reduced it (Fig.-6). In a study, on the effect of jujube extract on physicochemical properties of jujube cake similar results were found (Gharavi, 2016).

**Bread porosity**

The effect of jujube extract was significant on bread porosity so that porosity decreased with increasing jujube extract concentration. Generally, porosity refers to the volume created by the cavity or canals (Gilbert, 2002). In other words, porosity is the ratio of air volume to total volume (Razavi et al., 2014). The applied jujube extract had a Brix of 65, therefore the air volume in the samples was reduced due to extract replacement, which in turn reduce porosity (Fig.-7). Passage of time reduces the water content in the samples, whereas increases concentration...
consequently leads to reduced porosity (Fig. 8). In a study carried out by (Scanlon and Zghal, 2004) similar results were obtained, as bread porosity decreased with increasing extract concentration and the passage of time.

**Moisture percentage**

The results revealed that the effect of jujube extract was also significant on bread moisture percentage so that moisture percentage increased with increasing jujube extract concentration. Similar results were found by Gomez et al., (2003). Jujube extract contains sugar compounds and other carbohydrates such as pectin. Increase in extract concentration reduces water content, whereas soluble solids remain constant, so a reduction in moisture due to increase in extract application is not surprising (Fig. 9). Considering this fact that the ambient moisture is less than samples moisture, the samples will lose moisture over time (Fig. 10). Reduction in the moisture percentage over time has been previously reported (Pinarli et al., 2004).

**References**


