

# Investigation in physicochemical characteristics of jujube (*Ziziphus jujuba* Mill.) extract cake

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## Investigation in physicochemical characteristics of jujube (*Ziziphus jujuba* Mill.) extract cake

**Abstract:** In spite of freshly eaten, Jujube (*Ziziphus jujuba* Mill.) might be dried or processed into confectionary recipes in cakes, as one of the important products in food industries. The experiment was conducted based on complete randomized design with three replications. Treatments were control and three levels of jujube extraction (2, 4, and 6 percent) which added to cake's formulation and sampling in different time periods. In the present study, the process of baking was in four steps. First of all, dried jujube fruit was mixed with water and its brix was reached 15 using direct heat. In the second step, a final brix of 60 was obtained by rotary evaporator. Then, appropriate amounts of egg, sugar, yogurt, oil, 2, 4, or 6 % jujube extract was mixed using a blender. Finally, baking powder, flour, and vanilla were mixed and the mixture was placed in the oven set at 160 °C for 20 minutes. Physicochemical analysis showed that the cakes containing 4 and 6 % of jujube extract were the best treatments at all time periods. However, analyze of sensational test results revealed that especially panelists evaluations that 6 percentage extract sample was significantly different from the others.

**Key words:** fruity jujube cake; jujube extract; confectionary

## Preučevanje fizikalno kemijskih lastnosti dodatkov izvlečkov žižole (*Ziziphus jujuba* Mill.) pri izdelavi peciva

**Izveček:** Čeprav se plodovi žižole (*Ziziphus jujuba* Mill.) uživajo sveži, se lahko posušijo in predelajo v različnih slaščičarskih receptih v pecivo, ki je pomemben izdelek v živilski industriji. Poskus je bil izveden kot popolni naključni poskus s tremi ponovitvami. Obravnavanja so obsegala kontrolo in tri različne odmerke izvlečka žižol (2, 4, in 6 %), ki so bili dodani pri pripravi peciva in vzorčeni v različnih časovnih obdobjih. V raziskavi je priprava peciva potekala v štirih korakih. Najprej so pusušene plodove žižole zmešali z vodo in jih segrevali dokler njihova sladkost ni dosegla 15 briksov. V drugem koraku je bila končna sladkost 60 briksov dosežena s krožnim evaporatorjem. Nato so 2, 4, ali 6 % izvlečkom žižole dodali primerno količino jajc, sladkorja in jogurta ter zmes zmešali z mešalnikom. Nazadnje so dodali pecilni prašek, moko in vanilijo, vse dobro premešali in dali v pečico za 20 minut pri 160 C. Fizikalno kemijske analize so pokazale, da je bilo pecivo, ki je vsebovalo 4 in 6 % izvlečka žižole najboljše pri vseh časih obravnavanja. Kljub temu je analiza senzoričnega preiskusa odkrila, da so preiskusovalci ugotovili značilno različnost peciva s šestimi odstotki izvlečka žižol.

**Ključne besede:** sadno pecivo iz žižol; izvlečki žižole; izdelovanje slaščic

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## 1 INTRODUCTION

Interests have been raised about the potential effects of diet hobbies on controlling or preventing various diseases, during the last few decades. Therefore, practical foods play an undeniable role in decreasing health problems and improving health quality. The impact of some vegetable-based foods in decreasing chronic illnesses have been documented, at least in secondary metabolites derived from biologic activities (Crisosto et al., 2003).

As one of the productions in food industries, cake, has been considered by people principally children and teenagers. This product is a form of sweet dessert that is typically baked and consists of flour, oil (except sponge cake), sugar, and eggs (National standard of Islamic Republic of Iran, 2006). (*Ziziphus jujuba* Mill), commonly called jujube is a member of the buckthorn family (Rhamnaceae) originated from China. Jujube is known as tasty fruit and an effective herbal remedy (both fresh and dried). Jujube is one of the native plants of Iran, which is used for curing various diseases, digestive problem, feeling weak, fatness, urination issues, and diarrhea in traditional medical education in Iran and some other middle east countries. Also, in Iran, this plant is well-known as anti-diabetes medicine (Delfan et al., 2014). This fruit is high in vitamin C and on the other hand, its glucose quantity is 36.74 and between 65 and 71.77 percent in fresh and dried mode, respectively. Hence, it has been suggested as a compote and sweet production (Pareek, 2017). Nutritional comparison of jujube and apple showed that jujube consisted of higher phosphor (fivefold), potassium (twofold) and ascorbic acid (tenfold) than to apple (Qinqin et al., 2015). FAO suggested daily use of jujube, even one per day, for obtaining necessary vitamins such as C and B complex. Results of a study showed that dried form of jujube possessed 100 to 600 nanomole per gram and on the other hand, fresh form showed 100 to 150 nanomole per gram for AMP (adenosine monophosphate), GMP (guanosine 3':5'-monophosphate) (Qing-Han et al., 2012). Dried jujube is a rich snack and can be regarded as an impressive substitution for raisin and date in the cooking industry. Productions such as jujube's cake, jujube's butter, jujube's candy, and jujube's beverage have been commercialized. Moreover, jujube is also processed as sweetened fruit, smoked fruit, juice, jam, wine, mixed drinks, powder, and tea in China and South East Asia, (Esteki and Urooj, 2012).

Researchers have found various compounds such as cycloplex, alkaloid (Suksamrarn et al., 2005; Han et al., 2011), languid, and tryptoid in jujube fruit (Choi et al., 2011). Another study (Wang et al., 2010) discovered this

fruit contains fatty acids, beta-carotene, alpha-tocopherol, seven phenolic compositions such as catein, caffeic acid, AP katchin, folic acid, routine, P-hydroxy benzoic, and chlorogenic acid (Wang et al., 2011). Knowledge and technology on functional foods were first identified in the 1860s in Japan. Accordingly, governments decided to control different factors that lead to some illnesses among the population through increasing production and use of certain foods. Consequently, they effectively managed expenses related to health care and cure section. Functional foods industry was found through adding or thickening useful and omitting ineffective or harmful compounds, and their production and consuming market have become greater immediately (Bigliardi and Galati, 2013).

Functional foods are known as foods, which have beneficial effects on health. They play a vital role in decreasing health risks and improving health quality. Barley is one of the well-known cases of functional foods since it naturally has soluble fiber and is effective in decreasing cholesterol level (Zhen-Yu et al., 2011). For reaching to such situation, as mentioned earlier, a couple of food materials have been modified; for instance, orange juice fortified with calcium is considered a remarkable substance for bones. These metabolites overall, as active biological compounds, are less effective than medicines. However, if they are used regularly in considerable amounts as a part of daily diet, should have noticeable physiological effects for a long time (Hasler, 2009). Methanol and water have been used with flavonoids, saponite containers, antioxidant activity, and also two experiments were used with 2.2 diphenylene and 1.1 picryl hydrazil (DPPH), in order to control free radicals activities, and reducing strength methods for measuring antioxidant activity of juice (Xiaohong et al., 2014).

Anti-cancer and immunologic effect of polysaccharides in jujube has been documented (Xie et al., 2016). Ethanol extract, which is existed in jujube, shows protection effect against liver damages caused by CCL4 and also antioxidant mechanism in rats. Moreover, the significant impact of jujube juice was reported on improving liver damages in the result of ischemia/perfusion (Dongying et al., 2012). Chen et al., (2010) investigated the effects of aqueous extract of jujube fruit on liver damage in rats and concluded that high antioxidant effect of its extract (Chen et al., 2010). Since jujube grows as a native plant in Iran and there is no information about jujube-based products, therefore, the present study was aimed to produce a new fruity jujube cake. To this end, an experiment was outlined to test the effect of various factors on some physicochemical properties of fruity jujube cake.

## 2 MATERIALS AND METHODS

### 2.1 MATERIALS

Dried jujube was purchased from local market of Mashhad (Khorasan-e-Razavi province in Iran) and was kept in outdoor condition. White flour, with extraction degree of 81 percent, was bought from Golmakan Flour Factory (Mashhad, Iran). For this purpose, flour needed for all examinations were provided at one time and was kept under cold storage. Other ingredients for experiences such as sugar, liquid oil, and vanilla were provided from a confectionary, and also, fresh eggs and yogurt were purchased one day before daily baking of cakes and kept in the refrigerator.

### 2.2 METHODS

#### 2.2.1 Providing jujube's extract

At first, jujubes were washed carefully. The water as a solvent was added in scales of 1:4. The temperature for extraction and final brix was  $80 \pm 5$  °C and 60 °C, respectively. After washing, some scratches were made on fruit and then the fruit was extracted for 3 hours within water in 1:4 scales in above temperature. After reaching to brix 15, extraction was filtered with its pulps using quilted fabric. In order to improve the efficiency, remained pulps were washed and heated again and achieved extract was filtered by Buchner hopper and filter paper under vacuum condition. Eventually, for increasing density under vacuum, rotary evaporator was used with 45 °C and under 72 mbar vacuum.

#### 2.2.2 Improving density by rotary evaporator

For reaching appropriate density and brix 60 in dried jujube, after extraction and achieving brix 15, rotary evaporator machine (model 4003 made in Heidolph Company in Germany) was used for 2 hours in 45 °C and under 72 mbar vacuum.

#### 2.2.3 Providing and producing cake dough

Cake dough consisted of 225 g wheat flour, 175 g sugar, 150 g oil, 4 eggs, 150 g yogurt or milk, 2 g vanilla (Dimitra et al., 2011) and 2, 4, and 6 % jujube's extract for different samples. Sugar, eggs, oil, and jujube extract were mixed by an electric mixer for making cake dough (Elec-

tra EK-230M, made in Japan) with speed of 128 RPM for 4 minutes, and cream with bubbles was achieved. Then, vanilla was added to wheat flour and product added slowly to the cream. In this study, the treatments were the concentration of jujube's extract (in 3 levels of 2, 4, and 6 %) which was added as mentioned earlier. After that, 40 grams of provided dough was placed into special papers that were placed in casts with the aid of fabric cloth. Finally, baking took place in a laboratory oven with hot air (Zucchelli Forni, made in Italy) at a temperature of 170 °C for 20 minutes. After cooling, each of samples was put in PE bags and kept in room temperature for measuring different specifications.

#### 2.2.4 Cake's physicochemical tests

##### 2.2.4.1 Measuring pH

The pH of cake was measured by the method of (Arunepanlop et al., 1996) using a pH meter (Metrohm 691, made in Switzerland) (Arunepanlop et al., 1996).

##### 2.2.4.2 Measuring cake moist percentage

To perform this experiment, standard AACC, 2000 number 44-16 was used (AACC, 2000). For this purpose, samples were put in the oven (Jet Tech OF-O2G, made in South Korea) with 100-105 °C in 2 hours, 3 days, and 6 days periods.

##### 2.2.4.3 Measuring cake $a_w$

For determining  $a_w$ , an equal mass of each sample was completely smashed in certain periods (2 hours, 3 days, and 6 days after baking) and their water resistance was measured by  $a_w$  meter device (Novasina, MS1 model, made in England).

##### 2.2.4.4 Measuring cake special mass

For measuring cake special mass, mass substitution method with rapeseed was used according to AACC standard, 2000, number 72-10 (AACC, 2000). For doing so, a slice of cake in 2 x 2 centimeter from geometric center of cake was cut in specific periods (2 hours, 3 days, and 6 days after baking) and its special mass was measured.

#### 2.2.4.5 Hardiness of cake

Hardiness of cake at the time intervals (2 hours, 3, and 6 days after baking) was measured using a tissue texture instrument (QTS model 25 made in the UK) based on (Zhang et al., 2016). The maximum force required to penetrate a cylindrical tip (2 cm in diameter, 2.3 cm in height) at a speed of 60 mm min<sup>-1</sup> from the cake center was calculated as a hardiness index. The starting point and target point were 0.05 N and 25 mm, respectively.

### 2.3 DATA ANALYSIS AND EXPERIMENTAL DESIGN

The experiment was conducted based on complete randomized design with three replications. Treatments were control and three levels of jujube extraction (2, 4, and 6 percent) which added to cake's formulation and sampling was performed in different time periods (2 hours, 3 days, and 6 days after baking). One-way analysis of variance (ANOVA) was used to test the difference between the means of treatments and the mean data were compared according to Duncan's Multiple Range Test (DMRT) at 5 % level using SPSS ver. 23. Graphs were drawn by Microsoft Excel software ver. 2013.

## 3 RESULTS AND DISCUSSION

### 3.1 WATER ACTIVITY ( $A_w$ )

Effect of sampling method on  $a_w$  was significant ( $p \leq 0.01$ ) (Table 1). The average of 12 different treatments for  $a_w$  has been categorized using Duncan method (Table 2). The maximum  $a_w$  was observed from control sampling in 2 hours after baking and the sample of 6 % extraction in 6 days after baking had the minimum  $a_w$  (Table 2).

The (Figure 1) shows that as time passes, increasing in extraction content increased and  $a_w$  decreased. The evaluation of jujube extraction on physicochemical properties of buns, achieved the same results about cake. However, the slope was less in bun than cake (Qing-Han et al., 2013).

### 3.2 SPECIAL VOLUME

The results illustrated that the effect of sampling method was significant on special volume ( $p \leq 0.01$ ) (Table 1). Comparison of means showed that the maximum special volume was observed from sample of 4 % extraction in 2 hours after baking while the minimum special volume was related to control sample in 6 days after baking (Table 2). The average of 12 different treatments

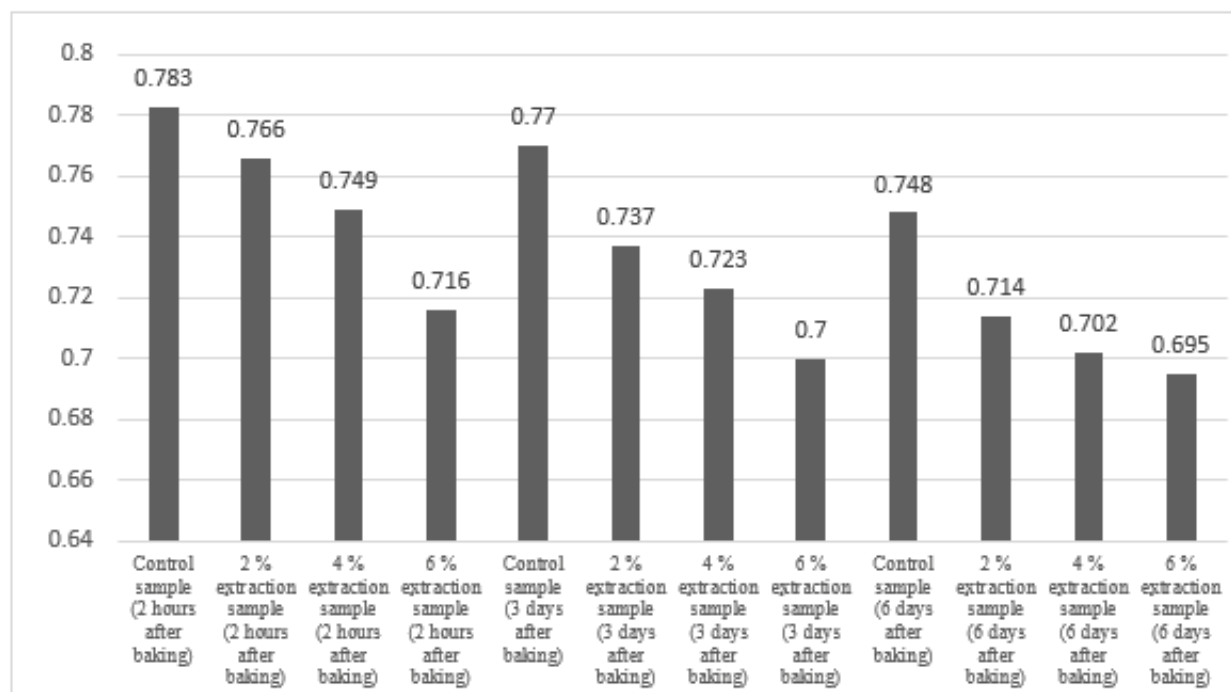


Figure 1: The comparison of  $a_w$  on different levels of sampling using Duncan method

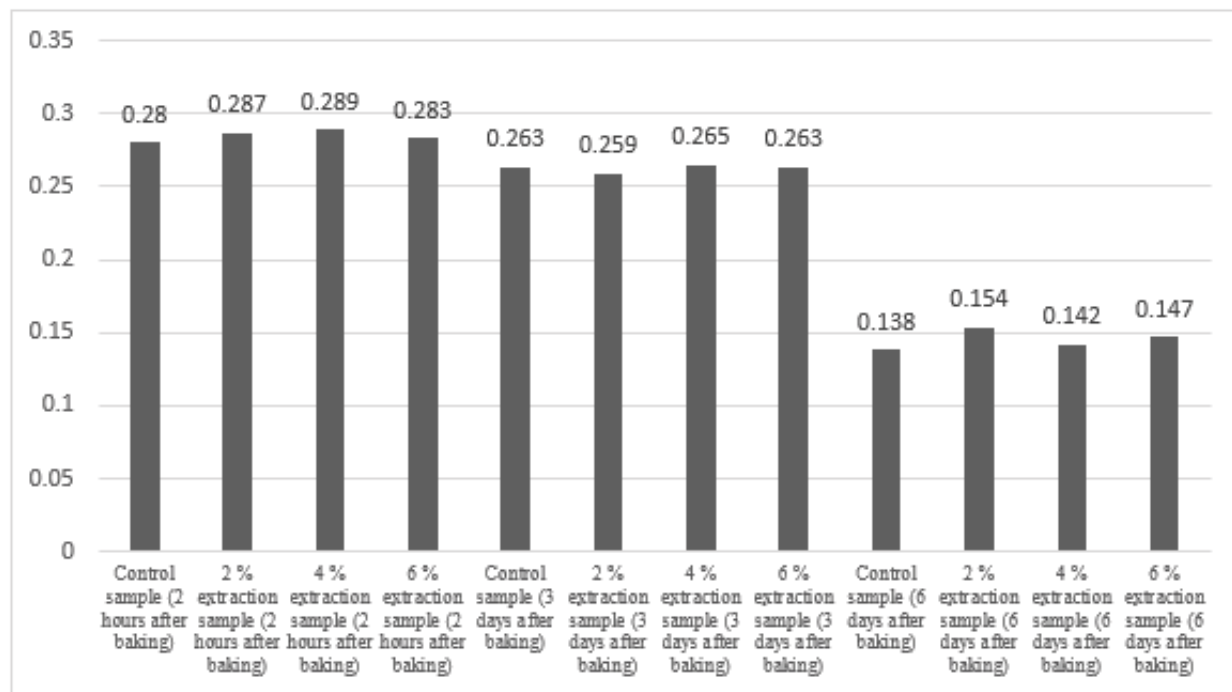


Figure 2: Comparison of special volume in different levels of sampling using Duncan method

for special volume has been categorized using Duncan method. Means with similar letters are not significantly different at  $p \leq 0.05$  (Figure 2). As results indicated, as

time passes, increasing in extraction content led to a decrease in special volume. According to another study that was conducted on the evaluation of the effect of ju-

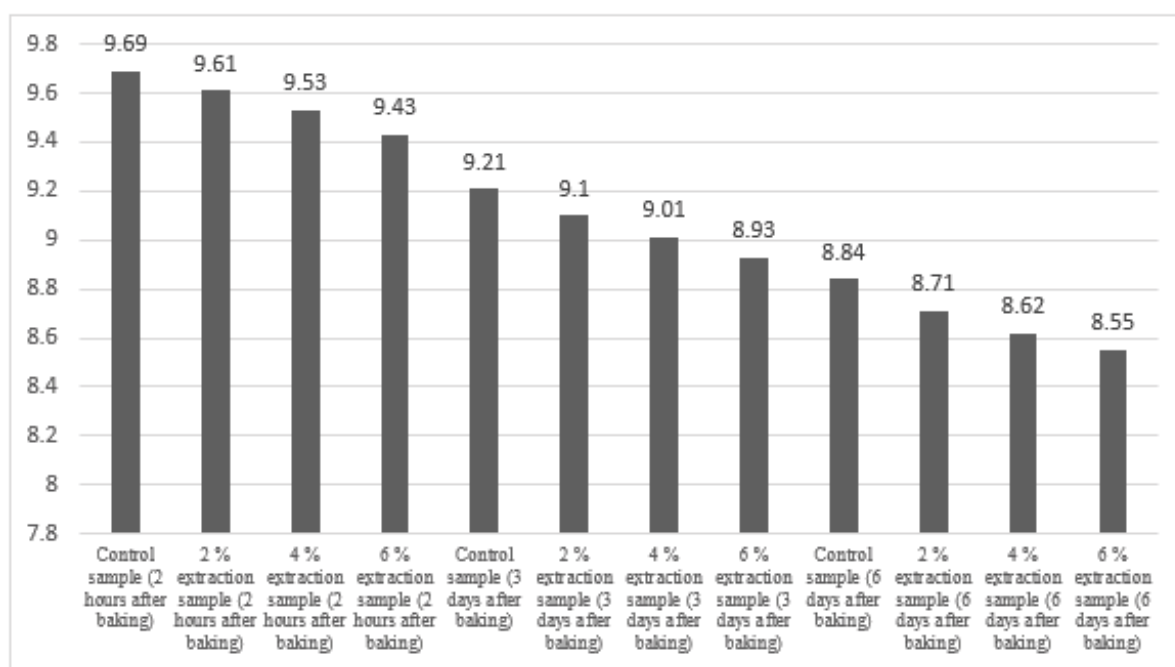


Figure 3: The comparison of pH on different levels of sampling using Duncan method

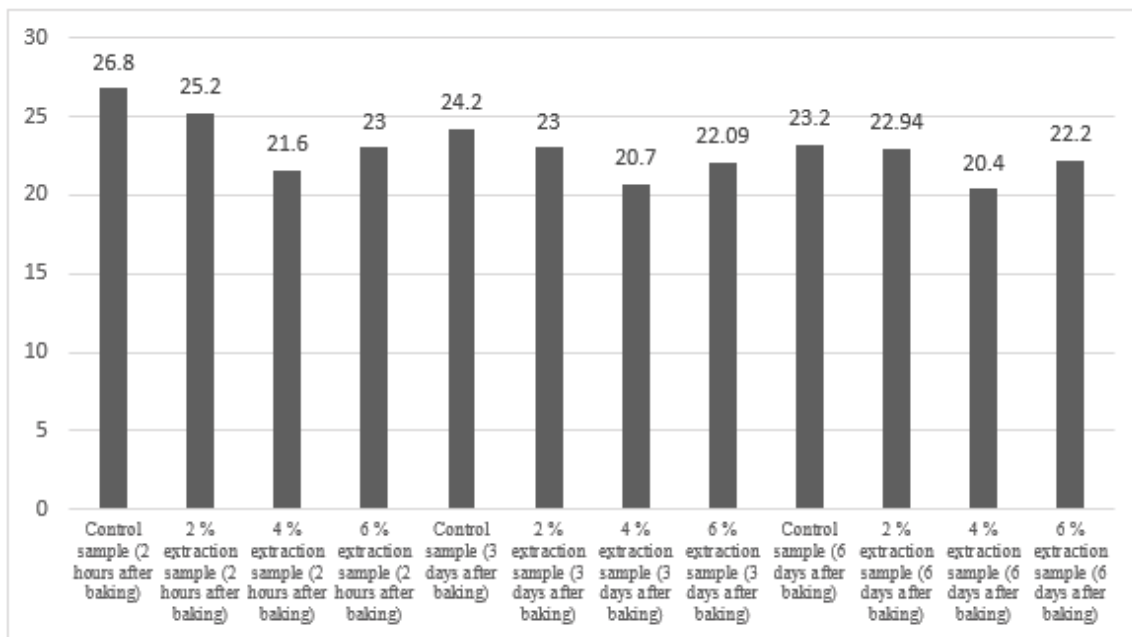


Figure 4: The mean moisture content of samples compared by Duncan method

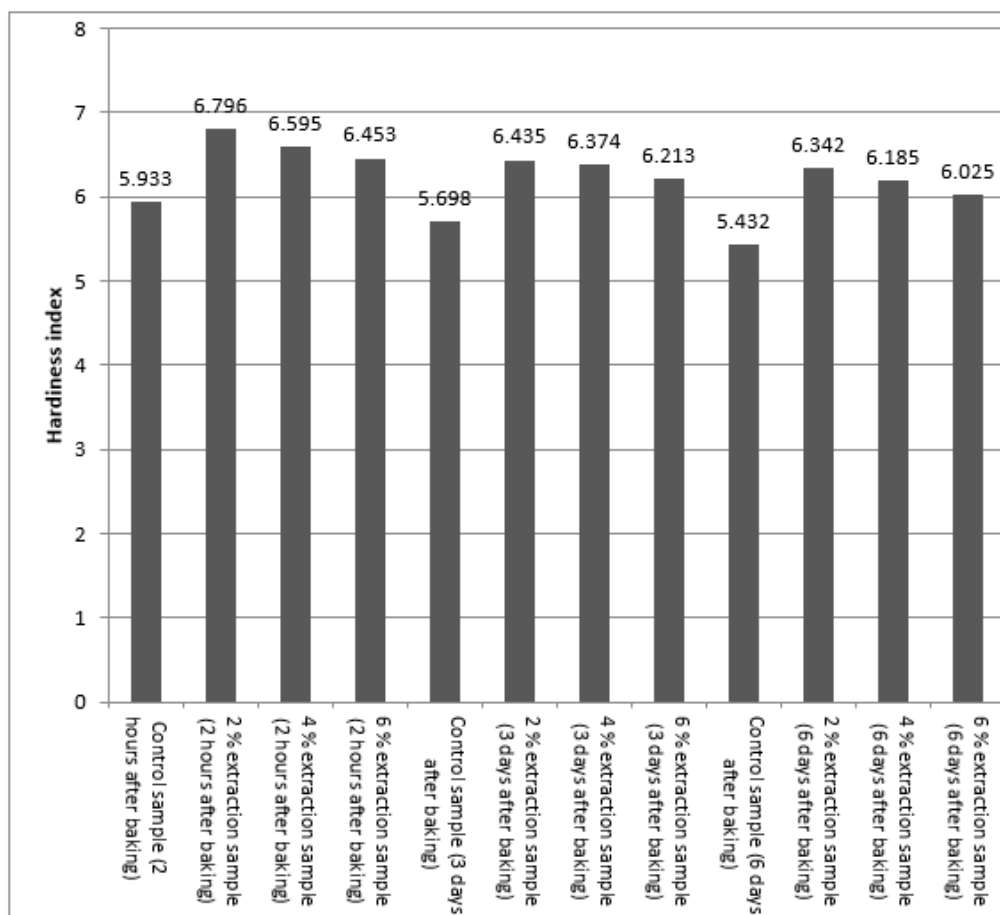


Figure 5: Comparison of hardness index in different levels of sampling using Duncan method



**Table 1:** Analysis of variance (mean square) for the effects of sampling treatments on physicochemical characteristics of jujube extracted cake

| Source of variation | df | $a_w$   | Special Volume | pH      | Moisture content | Hardiness |
|---------------------|----|---------|----------------|---------|------------------|-----------|
| Treatments          | 11 | 0.003** | 0.012**        | 0.465** | 9.874**          | 0.443**   |
| Error               | 24 | 0.00015 | 0.000007       | 0.00042 | 0.0503           | 0.000007  |
| C.V. (%)            |    | 1.72    | 1.17           | 0.23    | 0.98             | 0.04      |

\*\* Significant at  $p \leq 0.01$

**Table 2:** Mean comparison for the effects of sampling treatments on physicochemical characteristics of jujube extracted cake

| Treatments                                   | $a_w$     | Special Volume | pH     | Moisture content | Hardiness |
|--|-----------|----------------|--------|------------------|-----------|
| Control sample (2 hours after baking)        | 0.7825 f  | 0.280 f        | 9.69 l | 26.80 g          | 5.933 c   |
| 2 % extraction sample (2 hours after baking) | 0.7655 ef | 0.287 gh       | 9.61 k | 25.20 f          | 6.796 l   |
| 4 % extraction sample (2 hours after baking) | 0.7485 de | 0.289 h        | 9.53 j | 21.60 b          | 6.595 k   |
| 6 % extraction sample (2 hours after baking) | 0.7155 ab | 0.283 fg       | 9.43 i | 23.00 d          | 6.453 j   |
| Control sample (3 days after baking)         | 0.7695 f  | 0.263 de       | 9.21 h | 24.20 e          | 5.698 b   |
| 2 % extraction sample (3 days after baking)  | 0.7370 cd | 0.259 d        | 9.10 g | 23.00 d          | 6.435 i   |
| 4 % extraction sample (3 days after baking)  | 0.7230 bc | 0.265 e        | 9.01 f | 20.70 a          | 6.374 h   |
| 6 % extraction sample (3 days after baking)  | 0.7000 a  | 0.263 de       | 8.93 e | 22.09 c          | 6.213 f   |
| Control sample (6 days after baking)         | 0.7477 de | 0.138 a        | 8.84 d | 23.20 d          | 5.432 a   |
| 2 % extraction sample (6 days after baking)  | 0.7140 ab | 0.154 c        | 8.71 c | 22.94 d          | 6.342 g   |
| 4 % extraction sample (6 days after baking)  | 0.7020 ab | 0.142 a        | 8.62 b | 20.40 a          | 6.185 e   |
| 6 % extraction samples (6 days after baking) | 0.6950 a  | 0.147 b        | 8.55 a | 22.20 c          | 6.025 d   |

Means with the similar letters are not significantly different at  $p \leq 0.05$

jujube extraction on physicochemical properties of buns, same results about cake bun were achieved (Dairou et al., 2014). However, special volume after six days from baking was considerably lower than other cake samples.

### 3.3 PH

The results indicated that the sampling method was significant on pH ( $p \leq 0.01$ ) (Table 1). The average of 12 different treatments for pH has been categorized using Duncan method (Table 2). Comparison of means indicated that the maximum pH was observed from control sampling in 2 hours after baking while the minimum pH was related to the sample of 6 % extraction in 6 days after baking (Table 2). This study results indicated that as time passes and increasing in extraction content pH decreased (Figure 3). According to another study that was conducted on the evaluation of the effect of jujube's extraction on physicochemical properties of buns, same results about cake bun were achieved (Huan-xia et al., 2015).

### 3.4 MOISTURE CONTENT

Analysis of variance showed that the different methods of sampling had significant effects on moisture content ( $p \leq 0.01$ ) (Table 1). Duncan multiple range test was used to compare moisture contents of 12 different baking method and indicated means categories (Table 2). Results illustrated that as time passed and extraction increased, the moisture content decreased (Figure 4). Another study was conducted on the evaluation of the effect of jujube extraction on physicochemical properties of buns showed the same results about cake bun (McFarlane, 2005).

### 3.5 HARDINESS INDEX

Analysis of variance showed that the different methods of sampling had significant effects on hardness index ( $p \leq 0.01$ ) (Table 1). Duncan multiple range test was used to compare hardness of cake for 12 different baking method and indicated means categories (Table 2). Results

showed that as time passed and extraction increased, the hardness index decreased (Figure 5). Another study was conducted on the evaluation of the effect of jujube extraction on physicochemical properties of buns showed the same results about cake bun (Guynot et al., 2003).

#### 4 CONCLUSIONS

In this study, physicochemical characteristics and sensory properties of samples were analyzed. Cakes with 4 % and 6 % jujube extraction were chosen as best samples in every period (2 hours, 3 days, and 6 days after baking) for physicochemical tests. For sensory properties, specially panelists, 6 % jujube extraction sample in all time periods (2 hours, 3 days, and 6 days after baking) was chosen as the best sample compared with other samples. Furthermore, for keeping produced cakes for more than six days, adding preservatives seems to be essential to prevent corruption.

#### 5 CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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