Effect of storage time and temperature on the physicochemical and sensory characteristics of commercial apricot jam

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Abstract

Storage conditions are important factors for jam quality. The objective of this study was to monitor the physicochemical stability and sensorial profile of apricot jam during storage for 60 days at 5 °C, 25 °C and 37 °C. For that purpose, special attention was paid to total soluble solids (TSS), titratable acidity (TA), colour, free amino acids (FAA), total sugars (TS) and hydroxymethylfurfural (HMF). The decreasing parameter for jam at the end of storage under 5 °C, 25 °C and 37 °C, respectively, were 16.81%, 34.30% and 56.01% for FAA, and 5.52%, 9.02% and 7.46% for TS; likewise, the increasing were 19.81%, 22.94% and 25.07% for TA, 3.15%, 4.08% and 4.47% for TSS, 15.96%, 112.76% and 150% for HMF. Jam stability was better at 5 °C than 25 °C and 37 °C. The interaction time–temperature factor had significant effects on pH, TS, FAA and HMF, unlike TA, TSS and sensorial profile.© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

Apricot fruit (Prunus armeniaca. L) is native from China and is widely adapted to Mediterranean climate. It is consumed around the world due to its pleasant and delightful aroma (Gutierrez-Martinez, Schorr-Galindo, & Ragazzo-Sanchez, 2007). Nutritionally, apricot is a rich source of sugars, fibers, minerals, and vitamins like thiamine, riboflavin, niacin and pantothenic acid (Sartaj, Tariq, & KashifSarraz, 2011). In addition, apricot fruit is known to contain appreciable amounts of carotenoids (mainly β-carotene), and bioactive phytochemicals such as chlorogenic, caffeic, p-coumaric and ferulic acids (Dragovic-Uzelac, Levaj, Mrkic, Bursac, & Marija Boras, 2007).

The world production of apricot has increased considerably during the last 20 years. Indeed, the production doubled from 1.2 million tonnes in 1992 to 2.3 million tonnes in 2010. Apricot, the 16th cultivated fruit in the world, is largely cultivated in Mediterranean region. Algeria is currently the 5th world producer with 239,700 tonnes (FAO, 2010).

Apricot is a climacteric fruit with a very short storage life due in part to a high respiration rate and a rapid ripening process. Thus, in order to reduce post-harvest losses, numerous techniques and processes for fruit conservation into jam, jelly, marmalade, as well as nectar have been developed.

Historically, jams originated as an early effort to preserve fruit for consumption during the off-season. It is an intermediate moisture food prepared by boiling fruit pulp with sugar, pectin, acid and other ingredients (preservatives, colouring and flavouring substances) until obtaining a reasonably thick consistency. Generally, fruit jam storage at high temperature leads to a significant decrease of nutritive values and sensorial properties (Vidhya & Narain, 2011; Wicklund et al., 2005).

To our knowledge, the literature available at present is poor in references about evolution of apricot jam properties during storage in different conditions (Aslanova, Bakkalbasi, & Artik, 2010; Rababah et al., 2011). Thus, the aim of this paper is focused on the assessment and monitoring of physicochemical parameters and organoleptic quality of apricot jam during storage, and the determination of the interaction time–temperature effect.

2. Material and methods

2.1. Preparation of samples

Three units each from two batches of apricot jam marketed in Algeria where provided from the manufacturer. Based on the details indicated on the label, jam is composed of apricot pulp, sugar (sucrose), pectin (E440) and citric acid (E330). The samples were divided into three groups. The first group was stored at 5 °C, the second at 25 °C and the third at 37 °C. The tested
parameters were determined in the freshly manufactured samples of each batch, and after 20, 40 and 60 days.

2.2. Chemicals

Sodium hydroxide and methanol (HPLC grade) were purchased from Panreac Química SA (Barcelona, Spain). Individual amino acids were all purchased from Sigma–Aldrich Química SA (Madrid, Spain). Ultrapure water was obtained by using a Milli-Q system (Academic Gradient A10, Millipak™ 40, Millipore, Paris, France).

2.3. Physicochemical parameters

2.3.1. Hydrogen potential, titratable acidity and total soluble solids

Hydrogen potential measurements were performed using pH meter (Metrohm model 692, Herisau, Switzerland) at 20 °C. Total acidity (TA) was determined by titration with 0.1 N of sodium hydroxide solution. Briefly, 1 g of sample was put into a 100 mL beaker and 75 mL of distilled water were added. This solution was titrated until end point (pH = 8.2 ± 0.1). The volume of sodium hydroxide was converted to percentages of citric acid. Total soluble solids (TSS) were determined by measurement of the refraction index with a refractometer (Atago N1, Tokyo, Japan). Refractive index was recorded and expressed as percentages. Measurements were performed at 20 °C.

2.3.2. Colour evaluation

Jam colour was measured using a CR-200 Minolta Chroma meter (Chuo-Ku, Osaka, Japan). A Minolta standard-white reflector plate was used to standardise the instrument under CIE (Commission Internationale de l’Eclairage). Samples of apricot jam were filled into 60 mL glass assay tubes and CIE Lab values were determined. The L*, a*, b* colour values were determined using the 1976 CIELAB system.

The colour parameters were measured using Eq.(2).

\[ Cr = (a^2 + b^2)^{1/2} \]

(1)

where: Cr: chroma is the grade of quantitative difference of Hue parameter with reference to grey colour, a is a measure of red tones and varies from -a to +a (a = green, +a = red), and b is a measure of yellow tones and varies from -b to +b (-b = blue, +b = yellow).

\[ Hue = (\tan^{-1} b/a) \]

(2)

where “Hue”: Hue angle, is the qualitative attribute of colour. It defines the difference of a colour with referent to grey; L* represents the brightness measure and the luminosity at range from 0 to 100 (100 = white; 0 = black).

2.3.3. Free amino acid content

One gram of jam was mixed with 6 mL of ultrapure water and homogenized for 1 min with a vortex. The mixture was then centrifuged at 3000g for 10 min at 4 °C (Heraeus Fresco 21, Thermo Scientific, Germany) and filtered (0.45 μm). Free amino acid analysis was performed as reported by Özcan and Şensuya (2006), by HPLC with UV–vis detector (Water 2695, Alliance, Singapore). The chromatographic separations were performed on a Zorbax Bonus-RP, narrow-bore column using the isocratic mixture of 0.01 mM acetic acid in a 0.2% aqueous solution of formic acid. Individual amino acids, asparagines (Asn), prolin (Pro), glutamic (Glu) and aspartic acid (Asp), were quantified using their respective standards and results expressed as mg/100 g of jam.

2.3.4. Sugar content

The sugars were determined from 0.02 mL of the extract used for amino acid analysis. Glucose, fructose and sucrose contents were analysed by ion chromatography (Metrohm 850 system) using injection valve along with the Pixel Array Detector (PAD) anion exchange column (1–150 Metrosep-Carb) and isocratic high-pressure pump for the channel PAD 818 IC. Operating conditions reported by Moraga, Martínez-Navarrete, and Chiralt (2006) for performance liquid chromatography were used, with minor modifications (mobile phase NaOH 80 mM, at 0.9 mL/min flow rate).

2.3.5. Hydroxymethylfurfural

The HMF content was determined according to Rada-Mendoza, Olano, and Villamiel (2002). Samples were placed in a flask of 25 mL; 2 mL each of Carrez I and II reagents were added and the volume adjusted with ultrapure water. After decantation for 30 min, the supernatant was filtered (0.45 μm) and then injected (50 μL) into the chromatograph (Nova-Pak® C18 column at room temperature). The mobile phase consisted of methanol: water, using a linear gradient from 5:95 to 80:20 in 6 min. Isocratic elution was then continued for 6 min and, finally, initial conditions were re-established in 1 min and held for 10 min. The flow rate was 1 mL/min. The UV detector was set at 283 nm. The quantification was made using HMF standard and the results were expressed as mg/100 g of jam.

2.3.6. Sensory properties

All evaluation sessions were held in a food laboratory at the Universidad Politécnica de Cartagena and were conducted by an untrained panel consisting of 10 students (4 males and 6 females) with 26 years mean age. The jam samples were prepared at room temperature 3 h before serving. Colour, aroma, taste, spreadability and overall acceptability were evaluated according to the hedonic scale of nine points (9 = like extremely to 1 = dislike extremely) as reported by Basu, Shivhare, Singh, and Beniwal (2011).

2.3.7. Statistical analysis

The results were submitted to a bi-factorial (time and temperature) analysis of variance (ANOVA). The mean values were compared using the least significant difference test (LSD) at 5% level using infostat software. All the test were performed in triplicates and the results average (n = 3). Finally, Pearson’s correlation analysis was performed on the studied parameters.

3. Results and discussion

3.1. Effect of storage time and temperature on pH, TA and TSS

Prior storage, pH, TA and TSS values of apricot jam were 3.54, 0.82% and 64.42%, respectively. The pH and TA were higher than those found by Aslanova et al. (2010) for apricot jam, unlike TSS. These authors reported 3.34, 0.441% and 70.55% for pH, TA and TSS, respectively.

During storage, the decrease in pH was significant (p < 0.05) from day forty at 5 °C and day twenty at both 25 °C and 37 °C. After prolonged storage, the initial value of pH decreased to 3.39, 3.34 and 3.21 under temperature storage of 5 °C, 25 °C and 37 °C. Statistical analysis revealed that time–temperature interaction factor had a significant effect (p < 0.05).

The TA is one of a number of physicochemical parameters which affect product quality; to a large extent, acidity protects against the development of microorganisms. During storage, TA increased significantly (p < 0.05) from day forty under all temperature storage. At the end of period storage, the initial values increased to 0.98%, 1.01% and 1.03% at 5 °C, 25 °C, and 37 °C, respectively. Furthermore, the interaction time–temperature factor shows no significant effect (p < 0.05).
The TSS is primarily represented by sugars, with acids and minerals contributing. According to the Codex Alimentarius standard (CODEXSTAN, 2009), normal fruit conserves or preserves must contain ≥60% soluble solids. The TSS changes were not significant (p < 0.05) by storage time, temperature or the interaction between those factors. The TSS values found in this work at different storage time and temperature, ranged between 64.42% and 67.30%, were within values reported by Ferreira et al. (2004) for quince jams which ranked between 59.2% and 75.1%.

### 3.2. Effect of storage time and temperature on colour

One of the most important parameters to which consumers are sensitive when selecting foods is colour. Table 1 shows the changes in colour parameters for apricot jam during temperature and time storage. It was noticed that these parameters presented significant variations from day twenty. After 60 days storage, all parameters underwent significant reductions in values, the most important being values of L* and a* values of strawberry jams stored at 4 °C and 20 °C. In addition, Patras, Brunton, Tiwari, and Butler (2011) observed a significant decrease of lightness during storage (28 days at 15 °C) of strawberry jam. However, in another study, Igual, García-Martínez, Camacho, and Martínez-Navarrete (2013) showed that lightness values of grapefruit jam stored under room temperature were maintained during 90 days.

#### 3.3. Effect of storage time and temperature on free amino acids

Amino acids, a class of biologically active compounds present in food, are important for human nutrition and affect the quality of foods. Because amino acids take an active part in the Maillard reaction and browning processes, which determine the sensorial quality of food, are important for human nutrition and affect the quality of foods. Amide amines contributing. According to the Codex Alimentarius standard (ARCS, 2012), were quantified. Individual free amino acid content at day zero was 13.98, 55.98, 3.71 and 8.67 mg/100 g for Asn, Asp, Glu and Pro, respectively (Table 2). Statistical analysis revealed that interaction time–temperature had significant effect for all assessed free amino acids (p < 0.05). The reductions were higher with longer time storage and higher temperature. After 60 days, total free amino acid content decreased by 16.81%, 34.30% and 46.04% at 5 °C, 25 °C and 37 °C, respectively. This decrease might be due to the intervention of amino acid in non-enzymatic browning process as Maillard reactions (Buedo, Elustondo, & Uribicain, 2001).

#### 3.4. Effect of storage time and temperature on sugar contents

Apricot jam sugars were sucrose (22.49%), glucose (21.04%) and fructose (21.34%). The initial total sugars content of jam decreased by 5.52%, 9.02% and 7.46% after 60 days of storage at 5 °C, 25 °C, and 37 °C, respectively (Table 3). Statistical analysis revealed that the interaction time–temperature factor had significant effect (p < 0.05) on these individual sugars. Chauhan, Archana, Singh, Raju, and Bawa (2012) indicated that the total sugar content of the coconut jam decreased by 0.56% and 0.87% after storage for 6 months at 28 °C and 37 °C, respectively.

In our experiment, fructose levels decreased by 7.26% and 7.12% after 60 days at 5 °C and 25 °C, respectively. However, for the samples stored at 37 °C, fructose content decreased significantly at day twenty (7.49%) but increased after storage for 40 and 60 days. This increase can be explained by the hydrolysis of sucrose. The sucrose content decreased by 19.79% at 37 °C after 60 days while it decreased only by 6.48% at 5 °C.

### Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Temperature</th>
<th>Time (days)</th>
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<tbody>
<tr>
<td></td>
<td>5 °C</td>
<td>25 °C</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L*</td>
<td>30.72 ± 0.37</td>
<td>30.72 ± 0.37</td>
</tr>
<tr>
<td>a*</td>
<td>75.43 ± 0.93</td>
<td>75.43 ± 0.93</td>
</tr>
<tr>
<td>Cr</td>
<td>5.89 ± 0.26</td>
<td>5.89 ± 0.26</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L*</td>
<td>30.68 ± 0.27</td>
<td>30.32 ± 1.78</td>
</tr>
<tr>
<td>a*</td>
<td>75.19 ± 0.36</td>
<td>75.09 ± 0.67</td>
</tr>
<tr>
<td>Cr</td>
<td>5.64 ± 0.08</td>
<td>5.77 ± 0.05</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L*</td>
<td>26.27 ± 0.21</td>
<td>25.58 ± 0.10</td>
</tr>
<tr>
<td>a*</td>
<td>75.05 ± 0.30</td>
<td>74.88 ± 0.60</td>
</tr>
<tr>
<td>Cr</td>
<td>5.34 ± 0.11</td>
<td>5.14 ± 0.09</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L*</td>
<td>26.26 ± 0.08</td>
<td>25.57 ± 0.12</td>
</tr>
<tr>
<td>a*</td>
<td>74.87 ± 0.78</td>
<td>74.41 ± 0.85</td>
</tr>
<tr>
<td>Cr</td>
<td>5.10 ± 0.10</td>
<td>4.81 ± 0.02</td>
</tr>
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</table>

Values are mean ± standard deviation (n = 3).

A–C: within a row, different letters indicate significant differences (p < 0.05).

a–d: within a column, different letters indicate significant differences (p < 0.05).

LSD interaction time–temperature factor of L*, a* and Cr are 1.26, 1.50 and 0.37, respectively.

### Table 2

<table>
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<th>Time (days)</th>
<th>Parameter</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asn</td>
<td>55.98 ± 1.32</td>
</tr>
<tr>
<td></td>
<td>Pro</td>
<td>13.98 ± 0.22</td>
</tr>
<tr>
<td></td>
<td>Asp</td>
<td>8.67 ± 0.30</td>
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<tr>
<td></td>
<td>Glu</td>
<td>3.71 ± 0.03</td>
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<tr>
<td></td>
<td>FAAs</td>
<td>81.52 ± 1.10</td>
</tr>
<tr>
<td>0</td>
<td>Asn</td>
<td>54.91 ± 1.33</td>
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<tr>
<td></td>
<td>Pro</td>
<td>13.12 ± 0.88</td>
</tr>
<tr>
<td></td>
<td>Asp</td>
<td>8.34 ± 0.08</td>
</tr>
<tr>
<td></td>
<td>Glu</td>
<td>3.26 ± 0.20</td>
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<tr>
<td></td>
<td>FAAs</td>
<td>79.63 ± 1.14</td>
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<tr>
<td>20</td>
<td>Asn</td>
<td>49.19 ± 0.37</td>
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<tr>
<td></td>
<td>Pro</td>
<td>12.97 ± 0.16</td>
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<td></td>
<td>Asp</td>
<td>8.05 ± 0.08</td>
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<td></td>
<td>Glu</td>
<td>3.13 ± 0.22</td>
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<tr>
<td></td>
<td>FAAs</td>
<td>73.34 ± 0.35</td>
</tr>
<tr>
<td>40</td>
<td>Asn</td>
<td>45.63 ± 2.26</td>
</tr>
<tr>
<td></td>
<td>Pro</td>
<td>11.77 ± 0.49</td>
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<td></td>
<td>Asp</td>
<td>7.38 ± 0.27</td>
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<tr>
<td></td>
<td>Glu</td>
<td>3.04 ± 0.81</td>
</tr>
<tr>
<td></td>
<td>FAAs</td>
<td>67.82 ± 3.39</td>
</tr>
</tbody>
</table>

Values are mean ± standard deviation (n = 3).

A–C: within a row, different letters indicate significant differences (p < 0.05).

a–d: within a column, different letters indicate significant differences (p < 0.05).

LSD interaction time–temperature factor of Asn, Pro, Asp, Glu and FAAs are 2.57, 0.89, 0.38, 0.49 and 2.81, respectively.
storage was 0.94 ± 0.03 mg/100 g. With respect to the evolution of HMF content during storage, a slight increase was noted at 5 °C (15.96%) but a greater one was observed at 25 °C and 37 °C (112.77% and 150%, respectively). This result confirms a large dependence of the HMF formation on storage temperature (p < 0.05) between HMF and TA. Negative correlations were noted between HMF and TA, Otrak (2007) found similar results between lightness and both pH and TA of red grape cultivars. Moreover, there was a positive correlation (p < 0.001) between HMF and TA. Negative correlations were noted between HMF and pH, total sugar and total free amino acid contents.

3.7. Correlations

The correlation matrix of assessed parameters is presented in Table 5. There were statistically positive correlations (p < 0.001) between lightness (L) and total free amino acids, total sugars and pH. These results confirm that amino acid and sugar contents have an important role in non-enzymatic browning. However, a negative correlation was noted between lightness and both HMF and TA. Otrak (2007) found similar results between lightness and both pH and TA of red grape cultivars. Moreover, there was a positive correlation (p < 0.001) between HMF and TA. Negative correlations were noted between HMF and pH, total sugar and total free amino acid contents.

4. Conclusion

The results of our study supplied detailed information regarding the physicochemical and sensorial stability of commercial apricot jam. The sensory profile of the apricot jam was evaluated in terms of colour, aroma, taste, spreadability and overall acceptability; the physicochemical and sensorial stability of commercial apricot jam remained appreciative. In this sense, Chauhan et al. (2012) reported that the sensory attributes for colour, appearance, flavour and overall acceptability of the coconut jam samples showed a decreasing trend, while the spreadability remained almost constant throughout the storage period.
jam. A storage at 5 °C and 25 °C induced changes on the physicochemical parameters of apricot jam, but not as important as a storage at 37 °C. The decrease of free amino acid content was concomitant with sugar level indicating their implication in the non-enzymatic browning process. Sensorial quality was well preserved under investigated storage conditions. The interaction time–temperature had a significant effect on the apricot jam stability. The information obtained in the present study finds its practical application because it showed the behaviour of the jam during the period separating the production from the consumption.

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References


