

Research

Effect of storage time and temperature on the nutritional quality of commercial orange jam**Ouarda Djaoudene, Hayette Louaileche*****Laboratoire de Biochimie Appliquée, Faculté des Sciences de la Nature et de la Vie, Université de Bejaia, 06000 Bejaia, Algérie****Received date:** 29-01-2016; **Accepted date:** 14-02-2016; **Published date:** 02-03-2016Corresponding Author: H. LOUAILECHE
E-mail address: haylouaileche@yahoo.fr**ABSTRACT:**

The aim of the present study was to assess the effect of storage period and temperature on the nutritional quality of orange jam during storage for 30 days at 25 °C and 35 °C. For that purpose, special attention was paid to total sugars (TS), hydroxymethylfurfural (HMF), free amino acids (FAA), ascorbic acid (AA) and carotenoids. It was observed that storage conditions of jam led to statistically significant alterations for all monitored parameters. The decrease rates at the end of storage under 25 °C and 35 °C, respectively, were 12.5% and 15% for TS, 50% and 59.5% for FAA, 23.5% and 29% for AA and 3% and 19% for carotenoids ; likewise, the increasing were of 144% and 169% for HMF. The practical implications of this work are that the derived knowledge could be very useful to optimize storage conditions in order to improve the quality of this product.

KEY WORDS: Nutritional quality, Total sugars, Amino acids, HMF, ascorbic acid, carotenoids, orange jam, storage.**INTRODUCTION**

Currently, there is considerable demand for fruits and vegetables because they are considered as rich sources of some essential dietary micronutrients, and more recently they have been recognized as important sources of a wide array of phytochemicals that may benefit human health (Yahia, 2009). Nevertheless, many such products are seasonal and perishable. The seasonality and perishability of fruits explain the need to apply preservation technologies, including jam making. This technology is very typical in fruit preservation (Osvald & Stirn, 2008; Rababah *et al.*, 2012 ; Renna *et al.*, 2013).

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 (Wicklund *et al.*, 2005; Reichert *et al.*, 2015). Generally, fruit jam storage at high temperature leads to a significant decrease of nutritive values and sensorial properties (Vidhya & Narain, 2011). Orange jam, among other orange

derivatives, is a viable alternative to the economic exploitation of fruits, adding value to the fruit and promoting access to its beneficial constituents for the entire year. Fruit jams are commonly used with breads, cookies, and cake fillings, among others (Morlly & Prado, 2012).

To our knowledge, the literature available at present is poor in references about evolution of nutritional quality of orange jam during storage in different conditions. Thus, the aim of this paper is focused on the assessment and monitoring of sugars, HMF, free amino acids, ascorbic acid and carotenoid contents of orange jam during storage, and the determination of the interaction time-temperature effect.

METHODS**Preparation of samples**

Three units each from two batches of orange jam marketed in Algeria were used in the current investigation. Based on the details indicated on the label, jam is composed of fruits, sugar (sucrose), pectin, citric acid and preservative (E202).

The samples were divided into two groups. The first group was stored at 25°C and the second at 35°C. The monitored parameters were determined before storage of samples of each batch, and after 3, 6, 9, 12, 15 and 30 days.

Total sugar content

The total sugars were determined according to Dubois *et al.* (1956). An aliquot (0.5 ml) of jam extract was mixed with the same volume of phenol (5%) and 2.5 ml of sulfuric acid (95%). After stirring, the reaction mixture was incubated at 105°C for 5min. The absorbance was measured at 490 nm (spectrophotometer Uvline 9400, Secomam, Ales, France). Total sugar content was calculated using a standard curve of sucrose.

Hydroxymethylfurfural content

The HMF content was determined according to White (1979). Samples were placed in a flask of 10 ml; 100 µl each of Carrez I (potassium ferricyanide 15%) and II (zinc acetate 30%) reagents were added and the volume was adjusted with distilled water. After decantation, the supernatant was paper filtered. With a clarified solution containing 0.2% sodium bisulfite as reference and a similar solution without bisulfite as sample, a difference spectrum was obtained which represents only the HMF in the sample, without the interfering absorption of the jam. The HMF content was determined according to the following equation:

$$\text{HMF (mg/100g)} = (\text{A284} - \text{A336}) * 74.85$$

A284 and A336: absorbance values, respectively.
74.85: Specific factor of dilution and conversion.

Free amino acid content

Free amino acids content was determined using the method of Yemm and Cocking (1955). One milliliter of an extract [one gram of jam was mixed with 10 ml of distilled water then centrifuged (Nuve NF 200, Ankara, Turkey) for 20 min, 5000 rpm] was added to 0.5 ml of citrate buffer (0.2M, pH = 5) 1 ml of potassium cyanide (0.01 M) and 200µl of ninhydrin (1%). The reaction mixture was heated in a water bath for 15min at 100°C. After cooling, 2.3 ml of ethanol 60% were added. The absorbance was measured at 570 nm and results were expressed as mg glycine equivalent per 100g of jam with reference to a calibration curve.

Ascorbic acid content

Estimation of the ascorbic acid content was performed according to Mau *et al.* (2005). Ascorbic acid was extracted from 1g of jam samples with 10ml of oxalic acid (1%) and stirred for 30 min. After

centrifugation at 5000 rpm for 10 min, 100µl of the supernatant were mixed with 900µl of dichloroindophenol and the absorbance was measured at 515 nm. The ascorbic acid content was determined with reference to a calibration curve obtained with L-ascorbic acid. The results were expressed in mg per 100 g of jam.

Total carotenoid content

Carotenoid content was determined according to Choi *et al.* (2002). One gram of jam was mixed with 10ml of extracting solvent (hexane: acetone: ethanol, 50:25:25, v/v/v). After centrifugation for 10 min at 5000 rpm, the top layer of hexane containing the carotenoids was recovered, and the absorbance was measured at 430nm. The carotenoid content was estimated with reference to a calibration curve obtained using β-carotene. The results were expressed in mg β-carotene equivalent per 100g of jam.

Statistical analysis

Data were analysed using infostat software. Analysis of variance was performed by ANOVA procedure with two factors; the model included the effect of storage time and temperature. Means were compared by LSD analysis at a least significant difference of P < 0.05 value. Experiments were conducted in triplicates.

Results and discussion

Sugar content

Sugars are the most important constituents of fruit products and are essential factor for the flavor of the food products and act as a natural food preservatives (Pavlova *et al.*, 2013). From the results shown in Figure 1 it is evident that time and temperature of storage affected the total sugar content. The initial total sugars content of jam (69.3g/100g) decreased by 12.5% and 15% after 30 days of storage at 25 °C and 35 °C, respectively. Statistical analysis revealed that the interaction time-temperature factor had a significant effect (p<0.05) on content of these compounds. The losses in sugars calculated in this study are higher than those reported by Chauhan *et al.* (2012) and Touati *et al.* (2014). According to these authors, the sugar content was reduced by 0.56% and 0.87% after storage for 6 months of coconut jam at 28 °C and 37 °C, respectively and by 9.02% and 7.46% after 60 days of storage at 25°C and 37 °C, respectively in apricot jam. This difference is probably due to the quality of the fruits used, product formulation, etc. The decrease of sugar content might be due to the contribution of the reducing sugars to non-

enzymatic browning phenomenon and HMF formation (Pavlova *et al.*, 2013).

HMF content

Hydroxymethylfurfural is acknowledged as a deterioration indicator for several products containing carbohydrates (Korus *et al.*, 2015). This aldehyde is formed from the dehydration of hexoses in an acid medium or as a result of Maillard reactions and caramelization. Several authors claim that HMF reduces the nutritive value of many foodstuffs (Rattanathanalerk *et al.*, 2005). Consequently, HMF is an important component for jams because of their high carbohydrate content. HMF content of jams can be increased with storage at unsuitable conditions during marketing (Aslanova *et al.*, 2010). The HMF content of orange jam prior to storage was of 1.8 mg/100 g. With respect to the evolution of HMF content during storage, an increase was observed at 25 °C and 35 °C (144% and 169%, respectively). This result confirms a large dependence of the HMF formation on storage temperature (figure 2). Statistical analysis revealed that interaction time-temperature factor had a significant effect ($p < 0.05$) on HMF content. These results were consistent with the findings of Rada-Mendoza *et al.* (2004) who reported a significant increase of HMF content for peach jam after storage for 12 months, which achieved 316% and 577% at 20 °C, 35 °C, respectively. The formation of HMF might be attributed to sugar (figure 3) and amino acid degradations which occur in acidic medium (Naknean *et al.*, 2009; Anese & Suman, 2013).

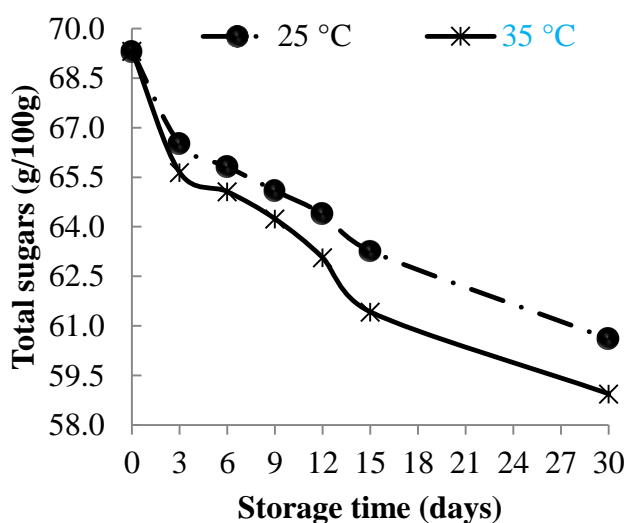


Figure 1: Changes in total sugar content during storage of orange jam

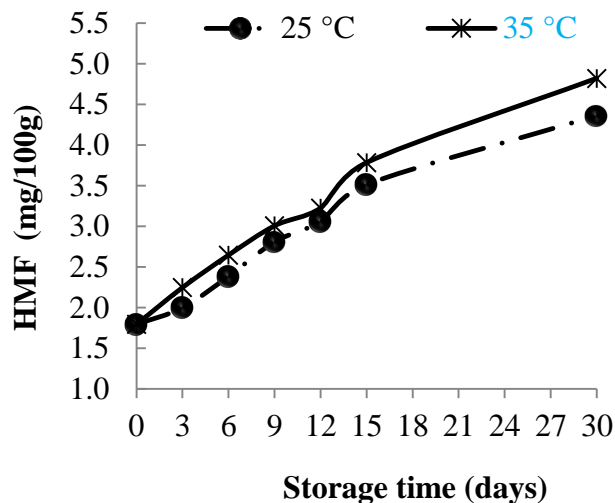


Figure 2: Accumulation of HMF during storage of orange jam

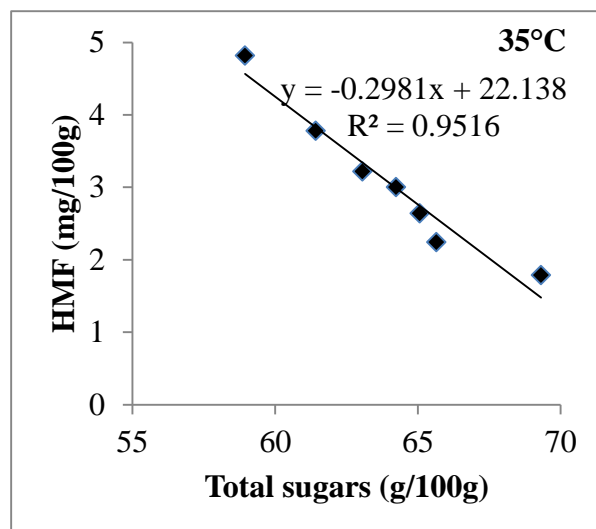
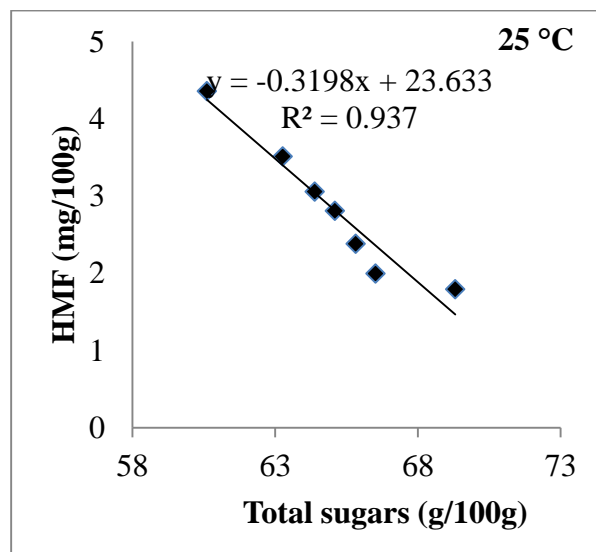


Figure 3: Correlation between HMF and total sugar contents of orange jam during storage

Free amino acids

In the literature, little is known about the impact of storage conditions on amino acid content of orange jam. Amino acids are important food compounds, contributing not only to the nutritive value of foods, but also providing several health benefits such as anti-mutagenicity as well as reduction in blood sugar and coronary heart diseases (Dajanta *et al.*, 2011). Furthermore, they are involved in multiple functions as a source of energy and as protein precursors and other contributing to the sensorial quality of foods; their determination is becoming more necessary as they can influence the quality of fruit-derived products (Serrano *et al.*, 2013).

Results presented in figure 4 showed that total free amino acid (FAA) content was affected during storage under the experimental conditions applied. There was a significant decrease in total free amino acid contents during storage. The reductions were higher with longer time storage and higher temperature. After 30 days, total FAA content decreased by 50% and 59.5% at 25 °C and 37 °C, respectively. Touati *et al.* (2014) reported that free amino acid content of apricot jam decreased by 34% and 46% after storage for 2 months at 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. Data presented in figure 5 revealed a negative correlation between free amino acid and HMF contents.

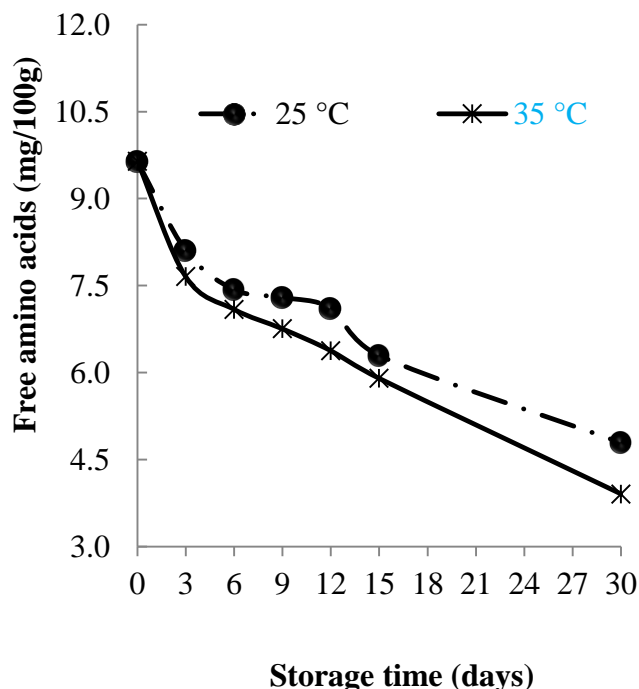


Figure 4: Changes in free amino acid content during storage of orange jam

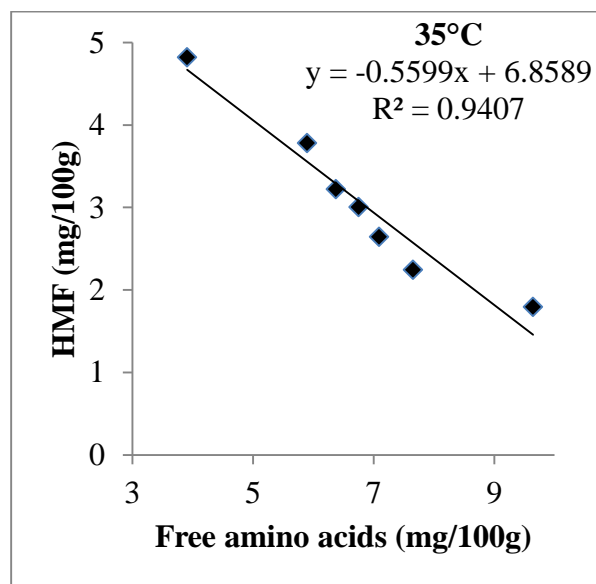
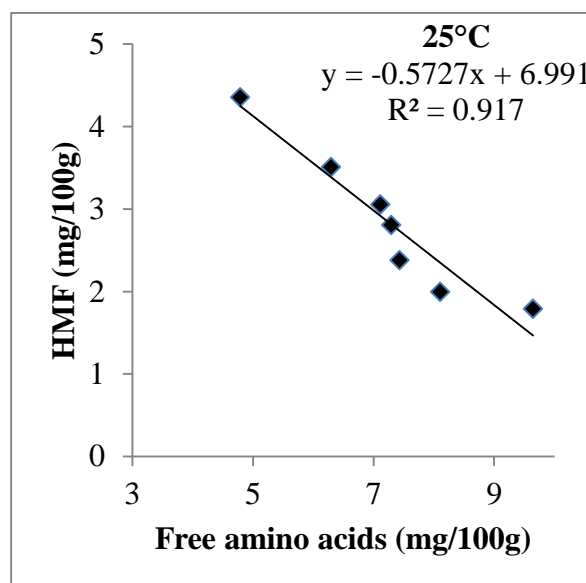


Figure 5: Correlation between HMF and free amino acid contents of orange jam during storage

Ascorbic acid content

Nutritional properties are related to the content of ascorbic acid, which has been reported to have potential beneficial health properties. Beside this effect, vitamin C is an efficient scavenger of reactive oxygen species; it is also involved in the endocrine system in the body and plays role in the synthesis of hormones (Haleng *et al.*, 2007). However, ascorbic acid is an unstable compound, under certain storage conditions such as elevated temperatures, and exposure to air and light. It was reported that several decomposition reactive products occur via the degradation of vitamin C and these compounds may combine with amino acids, thus result in formation of brown pigments (Duru *et al.*, 2011).

Figure 6 shows the changes in ascorbic acid content of orange jam during storage. Statistically, interaction time-temperature factor had a significant effect on the ascorbic acid content. In this work, jam showed a significant reduction of ascorbic acid concentration; after storage the concentration of this compound decreased by 23.5 and 29%, at 25 and 35°C, respectively. Similar results were reported by Patras *et al.* (2011) when studying changes in ascorbic acid content of strawberry jams stored at 15 °C for 28 days. In addition, Mazur *et al.* (2014) observed a significant decrease of ascorbic acid concentration during storage (6 months at 20 °C) of strawberry jam. However, in another study, Pavlova *et al.* (2013) showed that vitamin C values of peach and raspberry jams stored under room temperature were maintained during 90 days.

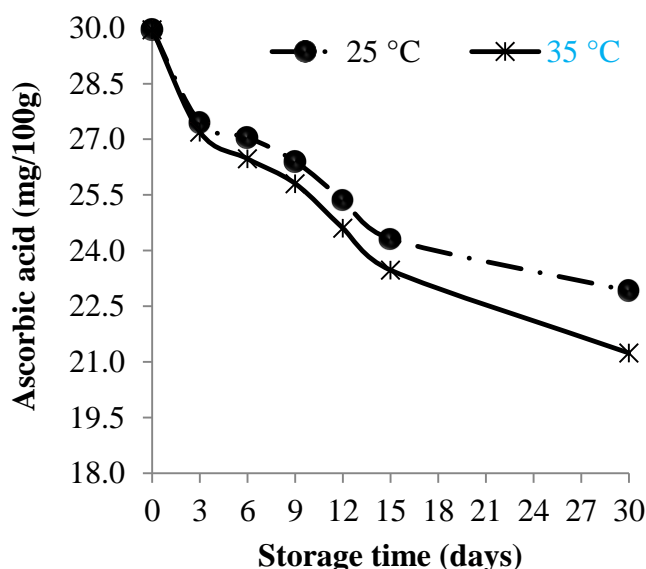


Figure 6: Changes in ascorbic acid content during storage of orange jam

Carotenoid content

In the literature, little information is available on the changes in carotenoid contents of jams during storage. Carotenoids are lipid-soluble pigments that play an important role in human health. Increased consumption of these compounds has been related to a decreased risk of developing several types of cancer, macular degeneration and cardiovascular disease (Dutta *et al.*, 2005). These bioactive compounds are the major dietary precursor of vitamin A, becoming retinol inside the human body. Besides its function as pro-vitamin A, the functional significance of this carotenoid is also due to its antioxidant action (Plaza *et al.*, 2011).

The total carotenoid content of the orange jam was evaluated in terms of β -carotene; evolution of these compounds during storage is presented in figure 7. Prior to storage, carotenoid content of

orange jam was of 0.75mg/100g. After prolonged storage, the initial value of total carotenoids decreased significantly ($p < 0.05$). After 30 days, carotenoid contents of the studied jam decreased by 3% and 19%, at 25°C and 35°C, respectively. In this sense, Igual *et al.* (2013) reported that the carotenoid content of the grapefruit jam showed a decreasing trend throughout 90 days of storage. The relative increasing of jam carotenoid content showed under temperature storage of 25 °C could be related to the isomerization reactions and fragmentation (Schieber & Carle, 2005; Rickman *et al.*, 2007).

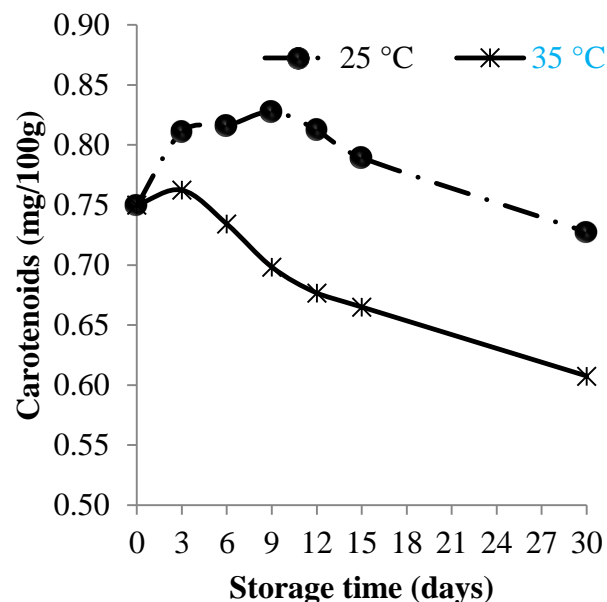


Figure 7: Changes in carotenoid content during storage of orange jam

CONCLUSION

It could be concluded that storage conditions of jam led to statistical significant alterations for all investigated parameters. Amino acids were the most affected by storage. On the other hand, HMF accumulation in fruit jam increased thus the determination of HMF is useful to assess the quality of jams during storage. The results revealed that the nutritional quality depletion of the investigated jam was more pronounced at 35°C than at 25°C. Thus, it can be concluded that jams should be stored at temperatures lower than 25°C because these products are still good sources of nutritional substances with antioxidant potential and offer an important opportunity to create a healthy, seasonally independent and mixed diet.

The information obtained in the present study finds its practical application because it showed the behaviour of orange jam during the period separating the production from the consumption.

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