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EFFECT OF PACKAGING MATERIALS AND STORAGE TIME OF CONCENTRATE ORANGE JUICE ON CHEMICAL PROPERTIE AND ANTIOXIDANT ACTIVITY

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ABSTRACT

A study was conducted to determine the effects of packaging materials, and storage time on physicochemical and antioxidant properties of commercial concentrate orange juice largely consumed in Algeria (Ramy). The juice was packaged in different packaging materials (glass, cardboard and plastic bottles) and stored for three months at room temperature. Total soluble solids, pH, titratable acidity, vitamin C, and antioxidant activity (DPPH method) were evaluated in freshly juice, and after 1,2, and 3 months of storage. The results showed that total soluble solids, pH, vitamin C and antioxidant activity decreased with storage time under different storage time, irrespective of packaging materials. On the contray, the acidity increased during storage. The juice in glass bottles did not show significant changes until the end of storage. It was conducted that glass bottles packing proved to be most suitable for orange juice storage, which maintained the better quality and antioxidant properties loss than rest of the packing materials.

1.Introduction

Orange (Citrus sinensis L) of the family Rutaceae is considered the most popular fruit. It is also well known as a rich source of antioxidants including ascorbic acid (vitamin C). A large portion of the citrus fruit produced worldwide is used in processed juices and other beverages, from among which orange juice is the most esteemed (Klimczak et al, 2007). Citrus fruits are known to be a source of bioactive molecules such as ascorbic acid, carotenoids, flavonoids, and phenolic compounds that all of them were found to be health promoting (Abeysinghe et al, 2007 ; Ghasemi et al, 2009 ; Manthey and Grohmann, 2001). In addition, some authors previously recognised that phenolic compounds and ascorbic acid were the key constituents of orange juices responsible for their antioxidant activity (Rekha et al, 2012). Packaging is an important aspect in the food processing industry as it serves the important fonctions of containing the food protecting against chemical and physical damage while providing information on product features, nutritional status and ingredient information (Anin et al, 2010). Various packaging materials such as high-density polyethylene, polypropylene, and glass are commonly used for packaging of fruits juices (Marsh and Bugusu, 2007). Different packaging materials influence the quality of the stored products differently. Therefore, the study of the effect of packaging materials on the quality parameters during storage is essential. In this study, orange juice was stored in plastic, cardboard and glass bottles at ambient temperatures. The aim of this study was to determine effects of packaging materials and storage time on chemical changes and antioxidant properties of orange juice.

2.Material and methods

2.1.Samples, packaging and storage condition

Three different materials packaging of commercial orange juice made from concentrate largely consumed in Algeria (Ramy) were used in the current study. The effect of packaging materials on the chemical and antioxidant properties of orange juice at different storage intervals was studied. The orange juice was packed in three different materials (glass, cardboard, and plastic bottles), chemical characteristics and antioxidant properties were monitored at 1, 2 and 3 months after storage. The fresh orange juice was bought from the local market and brought to the laboratory. The packed juices in different packaging were stored under room temperature. The experiment was replicated in triplicate for each treatment to adjust any uneven variation for chemical properties. After every one month, the samples from each packaging were collected for chemical analysis. The data were recorded for the juice quality characteristics including pH value, TSS (Brix), TA, ascorbic acid content, and antioxidant activity.

2.2.Total soluble solids (TSS), pH and titratable acidity (TA)

Total soluble solid in (Brix) was measured using a refractometer calibrated with distilled water at 20°C. The pH was carried at room temperature with a pH metre. Titratable acidity (TA) was determined by titrating 10 ml of the juice mixed with 3 drops of phenophtalein indicator against 0.1 N NaOH until the end-point at pH 8.2. The results were converted to citric acid and expressed as g/l of citric acid. All measurements were done is triplicate.

2.3. Ascorbic acid content

Ascorbic acid concentration was measured according to Klein and Perry, 1982. Orange juice (1 ml) was mixed with 10 ml of 1% metaphosphoric acid and then sonicated in an ice bath for 4 min. The samples were then centrifuged at 4000 x g for 5 min. Supernatants (10 ml) were pipetted into a tube and mixed with 9 ml of 2,6 dichloropheno lindophenol. The mixture was incubated in the dark for 10 min and the absorbance was measured at 515 nm using spectrophotometer. Results were expressed as mass of ascorbic acid equivalents per volume of orange juice, µg/ml.

2.4.Radical scavenging activity (DPPH assay)

The radical scavenging activities of the orange juice against 2,2- diphenyl-1-picrylhydrazyl radical were determined by UV-spectrophotometer at 517 nm by a slight modified method described by Brand-Wiliam et al, 1995. 1.95 ml of 0.1 mM DPPH of methanolic solution was added into 50 µl of the orange juice. The mixture was thoroughly mixed and kept in a dark place for 30 mn. The DPPH radical scavenging activity was calculated as follows : DPPH radical scavenging activity % = 100 (1- AS/AC), where AC is the absorbance of the DPPH radical without any antioxidant as control. AS is the absorbance reading of DPPH added to sample at 517 nm. Methanol was used as a blank. The antioxidant capacity of each sample was expressed as the amount of sample necessary to inhibit the initial DPPH.

2.5.Statistical analysis

Analyses were conducted in triplicate means and standard deviations were calculated by the Excel software (2007 version). One way ANOVA was applied to the different storing date using SPSS version 15 windows. Tukey's method was applied for comparisons of means; while differences were considered significant at $p < 0.05$.

3.Results and discussions

3.1.TSS content analysis

Important conditions and function of food packaging materials are that they should meet the aim of containing the food protect against chemicals, physical damage, provide information on product features, nutritional status and ingredient information (Anin et *a*l, 2910). The concentrate orange juice did not show a statitical change TSS content ($p< 0.05$) with all packaging materials, while the TSS content was markedly small difference in the juice when packed in cardboard bottles and plastic bottles. The range of TSS content from the first to end storage were (12 to 10.72), (12 to 10.07) and (12 to 9.91) Brix in the glass, plastic and cardboard respectively.. On the other hand, the TSS decreased with prolonging the storage period (fig 1). This indicates that the glass bottles were the most suitable packing for fruits juice under room temperature of storage. Similar results on the effect of packing materials on the total soluble solids have been reported in previous studies (Janse, 1994) investigated the physicochemical properties of orange juice and found changes in TSS due to different packing materials and storage conditions as well as storage duration..

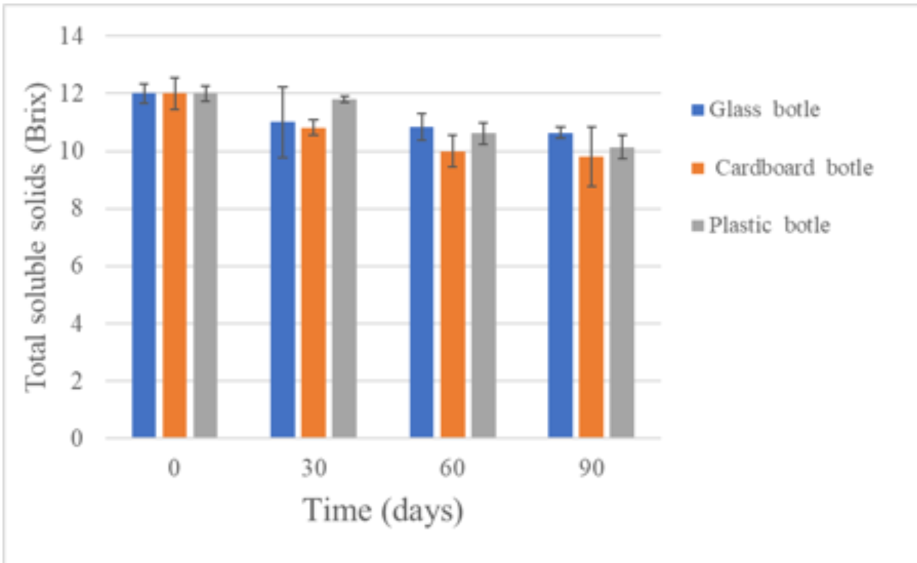

Figure 1. Effect of packaging materials and storage time on TSS of concentrate orange juice.

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3.2.pH / Titratable acidity analysis

Measurement of pH is an index for determining food quality especially during storage. The pH for concentrate orange juice in all packaging materials showed no significant decrease ($p< 0.05$) at the beginning of the storage (Fig.2). The pH for juice stored in glass and cardboard bottles ranged from 3.82 to 3.72 at room temperature, while in plastic packing, the pH ranged from 3.85 to 3.64. Similar decrease in pH with storage period were reported by (Muhammad et al, 2011) in apple pulp, (Wisal et *al*, 2013) in strawbery juice and (Durani et *al*, 2010) in apple pulp. The packaging materials and storage time has no significant effect on the titratable acidity of orange juice (fig 3). In this study, the TA value varied from 9.99 to 10.75 g/l and 9.79 to 10.77 in the glass and cardboard bottles packing respectively and 9.02 to 11.71 g/l under plastic bottles packing after three months of storage at ambient temperature. Similar results were also reported by Goyal and Srinivasan (Wisal et *al*, 2013). Increased acidity might be the production of organic acids, which can lead to reduction in pH and total soluble solids, and an increase in titratable acidity (Rivas et *al*, 2006). Acidity is a very important chemical predicate for conservation of fresh produce and food products by consumers as well as for the food industry, because it makes the food more resistant to deterioration by microorganisms and allows more flexibility in the addition of sugar, which is of particular importance in preparing ready-to drink beverages (Dell'ort Morgado et *al*, 2010). Decrease in pH value and increase in total titratable acidity during the storage period of 90 days may also be due to activity of some acid producing bacteria such as

Alicyclobacillus acidoterrestris as suggested by (Hussain, et *al*, 2011).

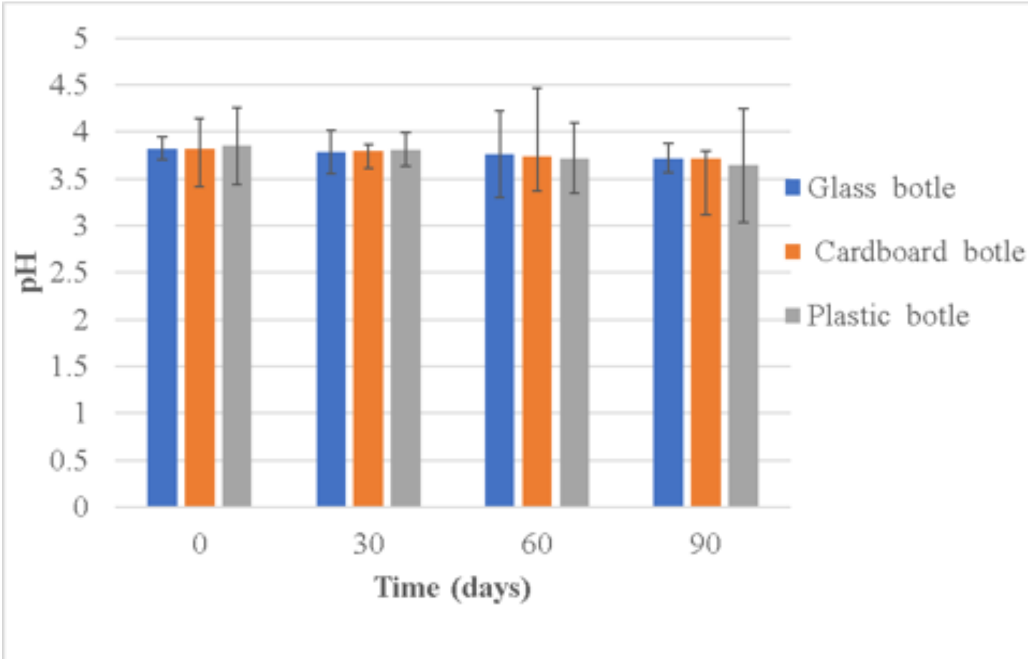

Figure 2. Effect of packaging materials and storage time on pH of concentrate orange juice.

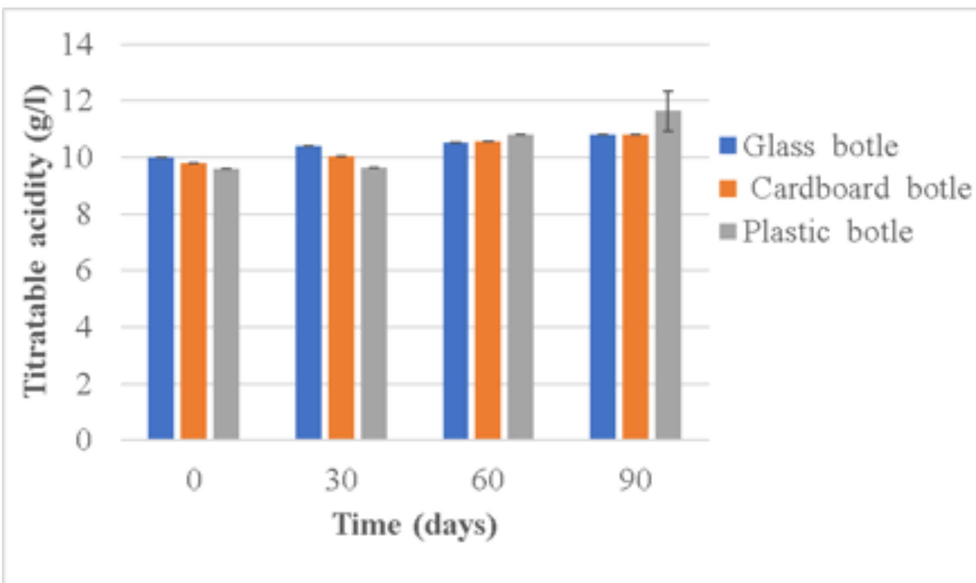

Figure 3. Effect of packaging materials and storage time on titratable acidity of concentrate orange juice.

3.3.Ascorbic acid analysis

Orange juice is a rich source of ascorbic acid, which is an important antioxidant (Rapisarda et al, 1999) and its concentration is also a significant indicator of orange juice quality. Modification in ascorbic acid could be a good indicator for enzymatic or non enzymatic degradative reactions taking place during processing or storage of the fruit (Skrede, 1996). According to (Fig.4), a significant decrease ($P < 0.05$) is observed in ascorbic acid content of all the experimental packages during storage at ambient temperature after 90 days compared to day 1, and its content was within a range of 0.687 to 0.432 and 0.702 to 0.418 and 0.708 to 0.323 g/l ascorbic acid with cardboard, glass and plastic bottles respectively. Vitamin C content of the concentrate orange juice decreased significantly ($P < 0.05$) with increased storage period. The juice stored at cardboard packaging showed lower losses of vitamin C (37 %), while the values for its degradation in glass and plastic packaging were (40 and 54 %) respectively. while plastic packaging have a lower barrier to oxygen, causing a loss of some ascorbic acid for oxidation, because vitamin C can easily be oxidized in the presence of oxygen by both enzymatic and non enzymatic catalyst (Jawaheer et al, 2003). Tamuno and Onyedikachi, 2015 reported that polyethylene packaging was not as effective in preserving vitamin C as the bottles. Also, Similar to the effect observed in the work, Alaka et al, 2003 and Berlinet et al, 2003 reported that the ascorbic acid decreased in different packaging materials..

This indicates that polyethylene (S) packaging material was not as effective in preserving vitamin C as the bottles. This is because light might have penetrated it causing vitamin C to leach out.

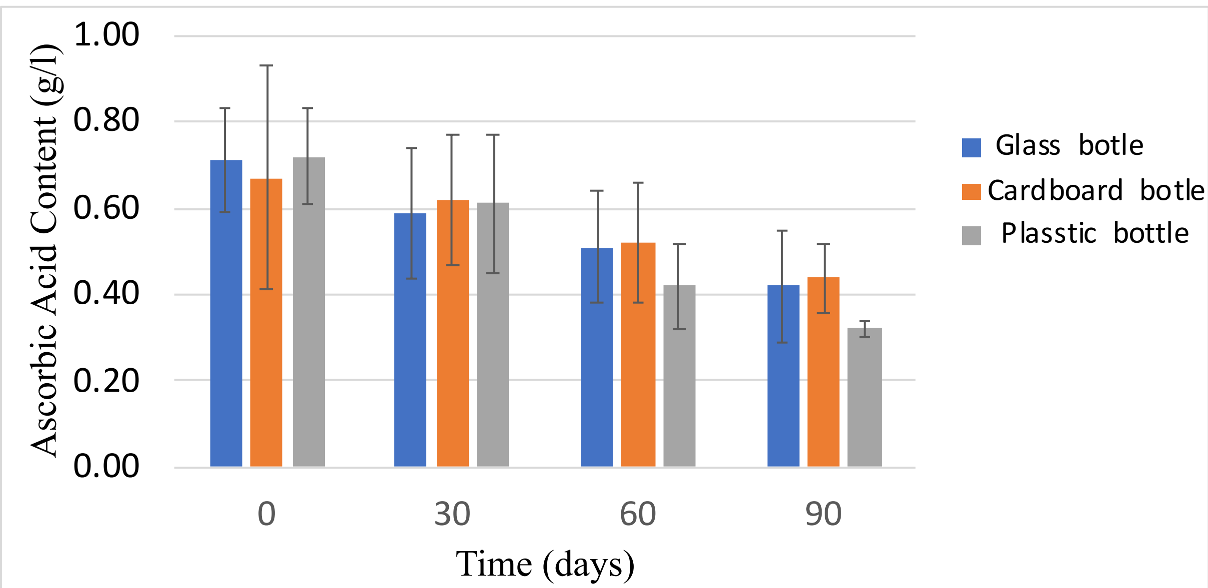

Figure 4. Effect of packaging materials and storage time on ascorbic acid content of concentrate orange juice.

3.4.Antioxidant activity analysis

Several studies reported a high correlation between phenolic content and antioxidant activity, however, other authors suggest that ascorbic acid is a powerful antioxidant in fruits and can give to the antioxidant potential of juices (Kuskoski et al, 2005 ; Reddy et al, 2010).The antioxidant activity of concentrate orange juice was evaluated using DPPH free radical scavenging and its shown in (Fig. 5). The values of antioxidant activity showed a reduction during juice stored in different packaging materials after 90 days at ambient temperature. The initial radical scavenging capacity was over 76 % for all the packaging materials, The reading of over 76 % remained after two months of storage for glass and cardboard and one month for plastic packaging.

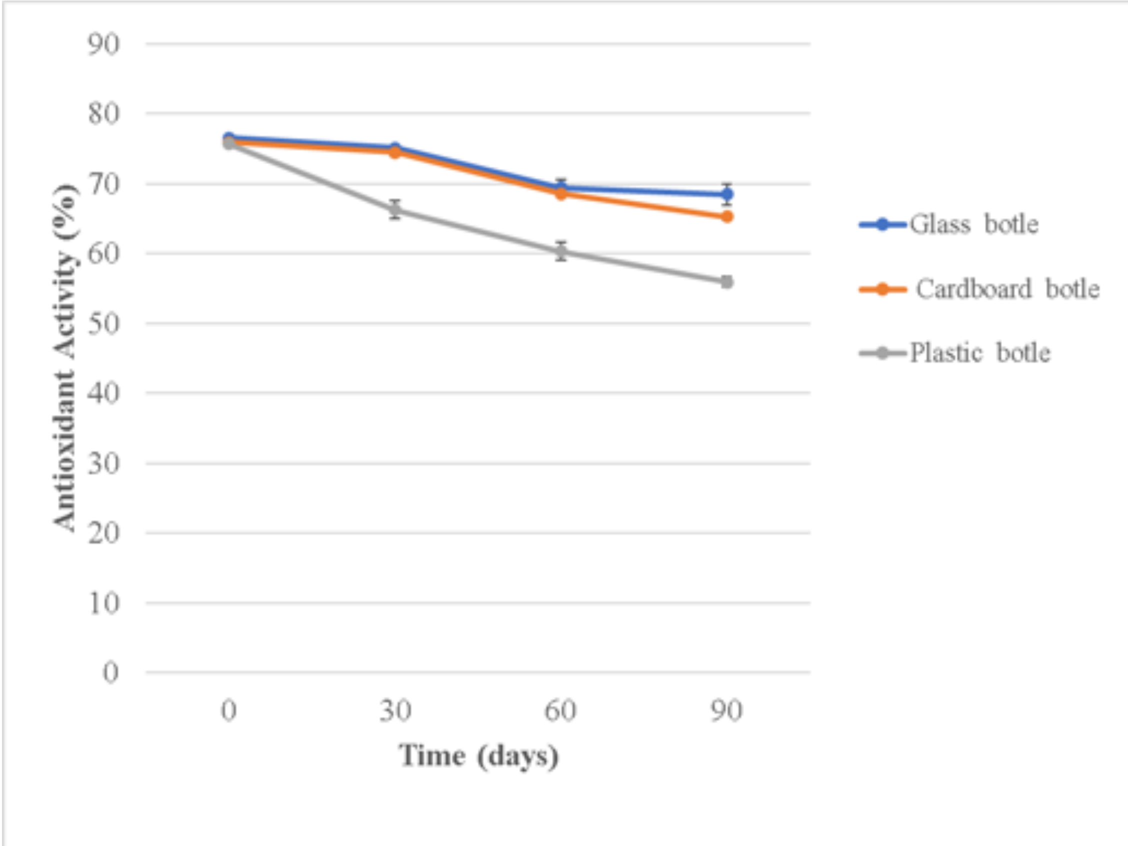

Figure 5. Effect of packaging materials and storage time on antioxidant activity of concentrate orange juice.

After one month, antioxidant activity of juice in plastic packaging decreased significantly to compared to the initial and one month. The decrease values of antioxidant activity content were observed up to 90 days of juice stored in three packaging materials ranged from 76.54 ± 5.1% to 68.42± 4.6% in glass bottles, 75.87±5.6 % to 65.22± 3.6 % in cardboard bottles and 75.68±5.3 % to 55.86±7.2 % in plastic bottles. For the first one month of shelf life, packaging materials did not affect the content of these bioactive responsible of antioxidant activity, whereas at three months, antioxidant capacity decreased significantly in juice with plastic bottle. The losses antioxidant activity value was lower at the end in juice stored in glass bottles packaging corresponding to 8.12 %. These results are in agreement with those reported in our previous study (Malecka et al, 2003). Walkowiak-Tomczak, 2007) has found that increase of oxygen, pH and temperature during storage reduced the antioxidant activity of the fruit concentrate. The result indicated that the decrease in the antioxidant activity may be linked to a decrease content of ascorbic acid in juice during storage. It is proved that the antioxidant activity was correlated to the concentration of ascorbic acid. Packaging in glass bottles and storage at ambient temperature should be encouraged as it efficient protect of vitamin C and antioxidant capacity of concentrate orange juice products. These results suggest that the juice sample studied should be consumed within the first month of storage on glass and cardboard packaging.

4. Conclusions

The concentrate orange juice presented some chemical changes during 3 months of storage in different packaging materials at ambient temperature. The most affected compounds were vitamin C and antioxidant activity observed in plastic bottles. The juice stored at glass packaging showed lower remarkable losses of vitamin C and antioxidant as compared to plastic and cardboard packaging. It is concluded that ragardless the glass bottles packing proved to be most suitable for concentrate orange juice storage, which maintained the better juice quality and bioactive loss than rest of the packing materials.

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