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Shelf-life and quality attributes in fresh-cut Galia melon combined with fruit juices

Ana Cecilia Silveira[a,*], Encarna Aguayo[b,c], Francisco Artés[b,c]

[a] Poscosecha de Frutas y Hortalizas, Departamento de Producción Vegetal, Facultad de Agronomía, Universidad de la República, Avenida Garzón 780, CP 12300 Montevideo, Uruguay
[b] Postharvest and Refrigeration Group, Department of Food Engineering, Universidad Politécnica de Cartagena-Technical University of Cartagena (UPCT), Paseo Alfonso XIII, 44, E-30203 Cartagena, Murcia, Spain
[c] Instituto de Biotecnología Vegetal-Institute of Plant Biotechnology, UPCT, Spain

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ABSTRACT

A new product composed of Galia melon pieces combined with natural Galia or Cantaloupe melon juices or different commercial juices was developed. The natural juices were freshly obtained and heat treated for 3 min at 70 °C. Each sample was composed of 100 mL of juice and 50 g of Galia melon pieces packed in polypropylene trays and stored at 5 °C up to 7 days. Microbial counts, vitamin C, total soluble solids, pH, titratable acidity and sensory analysis were performed. At the end of the storage, treatments with natural juices showed higher psychrotrophic (5.3–5.1 log cfu g^{-1}), total aerobic bacteria (4.3 to 4.6 log cfu g^{-1}) and lactic acid bacteria (5.1–5 log cfu g^{-1}) counts. This was due to the high pH (6.7 to 7.1) compared to the low pH (3.5) from commercial ones. Vitamin C contents were higher on melon pieces combined with natural juices. The sensory panel did not find major differences on sensory parameters. Considering the results, fresh melon pieces with Cantaloupe juice is a good alternative by the high vitamin C content and no added sugar. However, the shelf-life period could be extended reducing the pH which would ensure an optimal microbiological quality.

1. Introduction

In the last few decades, there has been an unprecedented increase in health problems. Associated with this concern, noticeable changes in population habits that include improved access to healthy foods and opportunities for physical activity, to reverse and prevent health problems have occurred. Therefore, fresh-cut fruits presented as peeled, cut and packaged or in fruit salads have become more and more appealing to consumers. In the same way, unpasteurized fruit juices, defined as the product obtained by pressing or squeezing fruits, has also increased in consumption (Harris et al., 2003). This consumer behavior is probably related to the characteristics of cut and natural juices, considered as fresh products, high vitamin and relatively low calorie content, which situates them as important components of a healthy diet (Raybaudi-Massilia, Mosqueda-Melgar, & Martín-Belloso, 2009).

Traditionally, thermal processing has been used to ensure the safety of foods against pathogenic and spoilage microorganisms, although this inevitably leads to destruction of heat sensitive nutrients, texture, color, and flavor (Balny, Hayashi, Heremans, & Masson, 1992). To maintain sensory and nutritional quality, the food industry seeks less aggressive treatments. Nowadays, there is a strong tendency toward consumption of fresh foods using minimal processing or reducing chemical preservatives. Juices directly obtained from fruits (not from concentrate), distributed through the refrigerated chain with a relatively short shelf-life are good examples of this (Esteve, Frígola, Rodrigo, & Rodrigo, 2005). Fresh-cut fruits alone or as blended components do not receive any heat treatment and are typically free of preservatives, making them susceptible to colonization and degradation by microorganisms, inducing undesirable changes in taste, aroma or color and/or safety risks (Tournas, Heeres, & Burgees, 2006). To respond to market needs, the feasibility of combining of fresh-cut Galia melon with different commercial fruit juices and natural Galia and Cantaloupe juices was evaluated. The aim of this study was to develop a new product consisting of a combination of Galia melon pieces and different juices. Specific objectives included (a) to evaluate the behavior of the combination from the microbiological, nutritional and sensory point of view during the shelf-life period, and (b) to determine the consumers preference.

* Corresponding author. Tel.: +598 2 3597191x213.
E-mail address: acsilver@fagro.edu.uy (A.C. Silveira).

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2. Materials and methods

2.1. Fresh-cut operations

Galia melon (*Cucumis melon* var. *cantalupensis* Naud.) of the commercial cultivar Garza was used. All fruits were grown in open fields, under the Mediterranean climate of Campo de Cartagena (Murcia, Spain). They were hand harvested and selected in a commercial packinghouse according to size, discarding damaged and immature fruits. These melons were transported about 25 km by car to the laboratory of the Technical University of Cartagena (UPCT) where fruits were stored overnight in a cold room at 5 °C and 90% RH. Fresh-cut operations were performed in a sanitized and refrigerated chamber at 10 °C. All fruits were pre-washed for 1 min with tap water at 5 °C in order to remove traces of soil and organic matter. Using sharp knives disinfected with chlorinated water (0.01 g L^{-1} for 3 min), melons were cut lengthwise into 8 sections of 3.5 cm in thickness. Slices were peeled and cut into 6 trapezoidal sections of 5 ± 0.6 cm × 3 ± 0.4 cm × 2.5 ± 0.3 cm. The pieces of melon were placed into a mesh container and immersed for 1 min in a wash basin that contained peracetic acid (PA) solution (68 mg L^{-1}, at 5 °C) (Silveira, Conesa, Aguayo, & Artés, 2008). Pieces were drained using a colander. The chemical characteristics as pH, titratable acidity (TA) and total soluble solids content (TSS) of the melon pieces are shown in Table 1.

2.2. Natural juices

For natural fruit juice preparation, Galia and Cantaloupe (*C. melon* var. *reticulatus* Naud.) melon fruits collected as for fresh-cut processing from the same packinghouse. For superficial disinfection before use, melons were pre-washed with chilled (5 °C) tap water and washed in a solution of PA (68 mg L^{-1}) at 5 °C for 1 min. Fruit were then peeled, cut into pieces and squeezed in a domestic juicer (Philips model HR 1850, Spain). Afterward, the obtained juice was filtered through a cloth strainer to remove major particles. Finally, melon juices were placed in glass bottles of 500 mL and taken to an autoclave (Selecta, model Presoclave 75, Barcelona, Spain) until reaching 70 °C for 3 min. The temperature was taken in center of the glass bottle. These juices were identified as natural since no additives (acidulants and or preservatives) were added after its preparation.

In addition to the natural juice above described, commercial clear juices of mango (Compal, Spain), melon and pineapple (Tropicana, Spain), white grape and apple juice (Don Simon, Spain) were purchased in a local supermarket. These juices were chosen based on a previous selection in which a sensory panel composed of 15 judges indicated out as most suitable, consider appearance and flavor, against a wide range consisting of nine commercial juices (all of the clear juices available in the supermarket).

2.3. Packaging

Samples of 50 g of Galia melon pieces to which 100 mL of natural or commercial juice was added, were packaged into polypropylene (PP) trays of 0.150 L. Melon pieces without juice was also studied. All trays were heat-sealed (Barket, Befor Model, Chassieu, France) on the top with a bioriented polypropylene (PP) film of 25 μm thickness (Plásticos del Segura S.L., Murcia, Spain). The transmission rates of the film were 1800 mL O_2 m^{-2} 24 h^{-1} atm^{-1} and 7100 mL CO_2 m^{-2} 24 h^{-1} atm^{-1} (data provided by the supplier). These trays were stored up to 7 days in a cold room at 5 °C and 90% RH. Three repetitions (trays) were evaluated for each treatment on day 0 (processing day), 3, 5 and 7 of chilling storage.

Table 1
pH, titratable acidity (TA) and total soluble solids content (TSS) of fresh-cut melon combined or not with natural and commercial fruit juices and stored at 5 °C during 7 days.

Treatment	0 days	7 days
pH		
Melon + pineapple juice	3.52 ± 0.01 d	4.79 ± 0.01 d
Melon + grape juice	3.40 ± 0.01 e	4.85 ± 0.06 d
Melon + apple juice	3.56 ± 0.02 d	4.93 ± 0.03 d
Melon + Galia juice	6.22 ± 0.04 b	6.67 ± 0.02 b
Melon + commercial melon juice	3.42 ± 0.01 e	5.34 ± 0.01 c
Melon + Cantaloupe juice	6.74 ± 0.02 a	6.99 ± 0.03 a
Melon + mango juice	3.41 ± 0.02 e	5.36 ± 0.01 c
Melon pieces	6.00 ± 0.05 c	6.74 ± 0.02 b
TA		
Melon + pineapple juice	0.570 ± 0.003 a	0.200 ± 0.003 a
Melon + grape juice	0.370 ± 0.004 b	0.200 ± 0.002 a
Melon + apple juice	0.340 ± 0.01 c	0.200 ± 0.01 a
Melon + Galia juice	0.070 ± 0.003 g	0.05 ± 0.01 d
Melon + commercial melon juice	0.280 ± 0.003 d	0.140 ± 0.002 c
Melon + Cantaloupe juice	0.060 ± 0.003 g	0.040 ± 0.002 de
Melon + mango juice	0.240 ± 0.01 e	0.160 ± 0.003 b
Melon pieces	0.110 ± 0.003 f	0.030 ± 0.002 e
TSS		
Melon + pineapple juice	13.07 ± 0.07 b	11.00 ± 0.02 c
Melon + grape juice	17.30 ± 0.02 a	12.37 ± 0.12 b
Melon + apple juice	12.23 ± 0.12 c	13.07 ± 0.07 a
Melon + Galia juice	10.70 ± 0.09 f	10.13 ± 0.03 e
Melon + commercial melon juice	11.60 ± 0.10 d	10.60 ± 0.10 d
Melon + Cantaloupe juice	11.23 ± 0.12 e	10.8 ± 0.02 cd
Melon + mango juice	12.40 ± 0.10 c	10.97 ± 0.02 c
Melon pieces	10.80 ± 0.12 f	10.20 ± 0.07 e

Mean value ± standard deviation error of the means ($n = 3$).
For each day of sampling, values followed by the same letter within the same row are not significantly different ($P \leq 0.05$).

2.4. Microbial growth

Microbial growth was determined on the processing day and after 3, 5, and 7 days at 5 °C. From each replicate, 3 random samples of 30 g fresh-cut melon combined with juice (15 g of melon plus 15 g of juice) or just 30 g of fresh-cut melon were collected from trays and homogenized for 2 min in 270 mL of sterile peptone buffered water (Scharlau, Barcelona, Spain) in a sterile stomacher bag with a Colorworth Stomacher 400 (Steward Laboratory, London UK). Serial dilutions were prepared and 1 mL aliquots were used to enumerate psychrotrophic, aerobic plate counts, *Enterobacteriaceae* and lactic acid bacteria (LAB). For yeast and molds, 0.1 mL was used. The following growing media (Scharlau, Barcelona, Spain) and incubation conditions were used: plate count modified agar for psychrotrophic and aerobic plate counts incubated at 7 °C or 30 °C for 7 days or 48 h respectively; violet red bile dextrose agar (pH 7.2) overlaid with the same medium for *Enterobacteriaceae* incubated at 37 °C for 48 h; and potato dextrose agar base with the addition of 100 mg L^{-1} of oxytetracycline (Sigma Chemical Co., St Louis, MO, USA) for yeasts and molds, incubated for 2 and 5 days at 22 °C, respectively. Man-Rogosa-Sharpe (MRS) agar was used for lactic acid bacteria (LAB) incubated at 30 °C for 72 h. All microbial counts were reported as log colony forming units per gram ($\log_{10}$ cfu g^{-1}). Microbial quality was evaluated according to the Spanish legislation for fresh-cut vegetables (RD 3484/2000, 2001, pp. 1435–1441).

2.5. Vitamin C

Vitamin C determination was based on the method reported by Zapata and Dufor (1992) with some modification. For extraction, 10 mL of a mixture of 19.2 g L^{-1} citric acid, 0.5 g L^{-1} ethylene diamine tetraacetic acid disodium salt, 50 mL L^{-1} methanol and 1.68 g L^{-1} NaF was added to 10 g of frozen product (5 g of melon pieces and 5 g of the juice) or 10 g of frozen melon pieces homogenized for 30 s and filtered through cheesecloth. The filtrate was collected in Eppendorf tubes and centrifuged at 10,500× *g* for 5 min at 5 °C; previously pH was adjusted to 2.40. The sample was flushed through a methanol activated Sep-Pak C18 cartridge (Waters, Milford, MA, USA) then passed through a Millipore 0.45 ìm membrane. For dehydroascorbic acid (DHAA) determination, 1 mL of 1,2-phenylenediamine dihydrochloride solution (35 mg 100 mL^{-1}) was added to 3 mL of extract for derivatization into the fluorophore 3-(1,2-dihydroxyethyl) furo[3,4-b]quinoxaline-1-one. After 37 min in darkness an aliquot of 20 ìL was injected into an HPLC (1100 Series; Agilent, Berlin, Germany) system using a reverse-phase C18 column (5 ìm, 30 cm × 3.9 mm, Waters ì-Bondapack) and a guard column (Nucleosil 5 ìm 100A). The mobile phase was methanol and water (5:95%) with hexadecyl trimethyl ammonium bromide (1.82 g L^{-1}) and potassium di-hydrogen phosphate (6.8 g L^{-1}, pH 4.59). The flow rate was fixed at 1.0 mL min^{-1} at 25 °C. Detection was performed at 245 nm for ascorbic acid (AA) and 348 nm for DHAA. Standards of L-ascorbate and dehydroascorbate were used (Aldrich Chemical Co., Germany). Total vitamin C content was calculated as the sum of AA and DHAA content and results were expressed as mg 100 g^{-1} fresh weight (f.w).

2.6. Total soluble solids content (TSS), pH, and titratable acidity (TA) determination

For physicochemical determinations, four pieces of melon from each repetition was crushed with a blender (Moulinex, Barcelona, Spain) and the juice obtained was used to determine total soluble solids (TSS), pH and titratable acidity (TA). TSS were determined with a refractometer (Atago N1, Tokyo, Japan) at 20 °C and expressed in °Brix. The pH was determined using a pH meter (Crison 501, Barcelona, Spain). TA values were obtained by titrating 10 mL of juice with 4 g L^{-1} NaOH to pH 8.1 (AOAC, 2002, pp. 2–3), expressing the results as g of citric acid per 100 mL.

2.7. Sensory evaluation

A semi-trained panel (7 men and 8 women; aged 25–63) was responsible for sensory evaluations using a 9-point scale (Gómez-López, Orsolani, Martínez-Yépez, & Tapia, 2010). Panellists evaluated the combination of melon pieces combined with natural or commercial juice. The flavor characteristics evaluated were visual appearance and flavor, where 1 = inedible, 3 = poor, 5 = fair, 7 = good, and 9 = excellent. Color was evaluated similarly, where 1 = dull color, 5 = fair and 9 = undisturbed living color. Overall quality refers to the overall appreciation of a sample measured on the same scale. In all the scales, the limit of marketability was defined as score of 5.

2.8. Statistical analysis

The experiment followed a completely randomized design of three replicates per treatment. Statistical analysis of data was performed using Statgraphic Plus version 2.1 (Manugistic, Inc., Rockville, Md., USA). The effect of fresh-cut melon and juice combination (treatment) and the storage time were analyzed using two way ANOVA with LSD test at 95% confidence interval. Significance for all statistical analysis was defined as $P < 0.05$.

3. Results and discussion

3.1. Microbial growth

Psychrotrophic and total aerobic bacteria load gradually increased with storage time in all treatments (Fig. 1A and B). On the processing day, melon pieces combined with commercial juices showed the lowest microbial load (below limit of detection). Otherwise, melon pieces combined with natural Galia and Cantaloupe juices showed psychrotrophic and total aerobic bacteria population of about 1 log unit lower than the melon pieces without juice. The greatest differences among treatments in both bacterial groups were found after 7 days of storage. In general, three groups were identified, one corresponding to the melon pieces with commercial juices, reaching levels between 2.8 and 3 log cfu g^{-1}; a second included melon pieces with natural Galia and Cantaloupe juices, showing a load between 5.2 and 5.4 log cfu g^{-1} and the third one with the melon pieces without juice with counts among 5.8 to 6.2 log cfu g^{-1}. The use of mango juice provided a total aerobic bacteria load slightly higher than the other commercial juices, which could be due to a less acidic pH, compared to the other commercial juices that favored the microbial growth.

However, in *Enterobacteriaceae* population no differences were found between the melon with commercial and natural juices after 5 and 7 days of chilled storage. In both days, the highest counts occurred in melon pieces without juice with a load between 2 and 3 log cfu g^{-1} (Fig. 1C). No LAB growth was found on the processing day (Fig. 1D). At days 3 and 5, the melon pieces combined with natural Galia and Cantaloupe juices showed the highest counts being between 1 and 3 log units higher than the counts registered in melon with commercial juices. After 7 days of storage, LAB counts in melon without juice surpassed in 1 log unit the counts of the fresh-cut melon with natural juices.

The reduced microbial counts monitored in melon pieces with commercial juices, could be due to the juices characteristics which have undergone a pasteurization process, frequently combined to an acidification with organic acids with the purpose of pH reduction, determining an unfavorable medium for bacterial growth (Raybaudi-Massilia et al., 2009). The pH reduction causes a depression of internal pH of the microbial cell by ionization of undissociated acid molecules, causing a disruption of substrate transport by altering cell membrane permeability or reduction of proton motive force and chelation of metal ions essential for microbial growth (Eswaranandam, Hettiarachchy, & Johnson, 2004; Stratford & Eklund, 2003). In this sense, natural Galia and Cantaloupe juices had two fold higher pH values (6.2 and 6.7 respectively) than those of the commercial ones (3.4–3.5), as shown in Table 1, facts that support the hypothesis of the pH effect on the microbial growth. However, the mild heat treatment to which these juices were subjected kept them optimal to consume after 7 days at 5 °C (data not shown). The positive effect of the application of mild heat treatment for reducing the microbial load of different plant derived products it has been widely reported. According to Char, Guerrero, and Alzamora (2009), mild heat (57, 59, 60 or 61 °C) reduced the *Listeria innocua* counts in orange juice, especially when 61 °C was used. A treatment of 80 °C for 5 min was enough to eliminate *Escherichia coli* (8.6 log cfu mL^{-1}) and *Salmonella typhimurium* (8.7 log cfu mL^{-1}) in papaya pulp nectar (Parker, Esgro, Miller, Meister, Toshkov, Engeseth & 2010). LAB bacteria are usually associated with undesirables physical and especially sensory changes. However, the increased presence of LAB on fresh-cut melon combined with natural juices can be regarded as not entirely negative, since some bacteria within this group are known to have inhibitory effects against foodborne bacterial pathogens (Trias, Bañeras, Bañosa, & Montesino, 2008). All the combinations

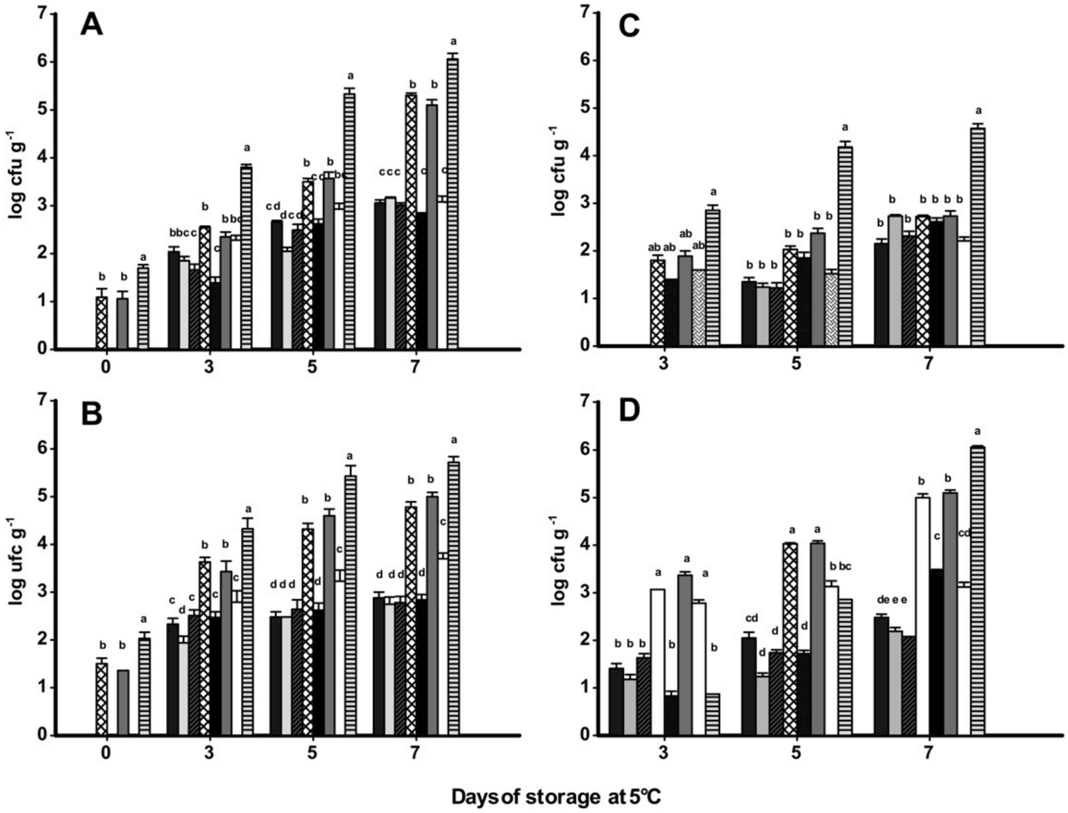

Fig. 1. Microbial growth ($\log_{10}$ cfu g^{-1}) of fresh-cut melon combined or not with commercial and natural juices and stored under modified atmosphere packaging at 5 °C up to 7 days. (A) psychrotrophic (B) mesophilic (C) *Enterobacteriaceae* (D) lactic acid bacteria .Vertical bars represent standard error of the means ($n = 3$). Melon + pineapple juice; Melon + grape juice; Melon + apple juice; Melon + Galia juice; Melon + commercial melon juice; Melon + Cantaloupe juice; Melon + mango juice; Melon pieces. For each day of sampling, values followed by the same letter are not significantly different ($P \leq 0.05$).

evaluated allowed to keep the product fit for consumption for at least 7 days at 5 °C, since the microbial loads obtained at this date were lower than the legal limit (7 log cfu g^{-1}). The microbiology was not the limiting factor in the product development.

3.2. Vitamin C juice contents

Regarding the vitamin C, higher initial values were measured on the combinations of fresh-cut melon with natural juices and within these, in melon pieces with Cantaloupe juice which recorded a 32% more than melon with Galia juice. This behavior was expected because Cantaloupe melon has high vitamin C content with values among 36–46 mg 100 g^{-1} f.w. Combinations with commercial juices did not differ statistically among themselves with values between 8.46 and 7.52 mg 100 g^{-1} (Fig. 2). A similar initial higher AA trend was found on fresh-cut melon in Cantaloupe and Galia juice (data not shown).

The results shown that although the heat treatment applied to the Galia and Cantaloupe juice was not excessively severe, it did result in a reduction in vitamin C since the melon pieces with Galia juice presented 12% less vitamin C than the melon pieces (without juice).

As expected, in all treatments, a progressive decrease on vitamin C content and AA was found, meanwhile levels of DHA progressively increased (data not shown) over the shelf-life period. Under stress conditions, ascorbate oxidase has been described to promote the transformation of AA to DHA (Wright & Kader, 1997). In the case of fresh-cut melon, at the end of the experiment, the vitamin C contents reached 71% of the initial value. Likewise, the greatest retention occurred in the combination with Cantaloupe and Galia juices which at the end of the storage lost 26 and 35% of initial value, respectively. The melon pieces combined with commercial juices had losses between 41 and 54%. AA was strongly degraded with losses ranging from 16 to 31% of the initial value (data not shown).

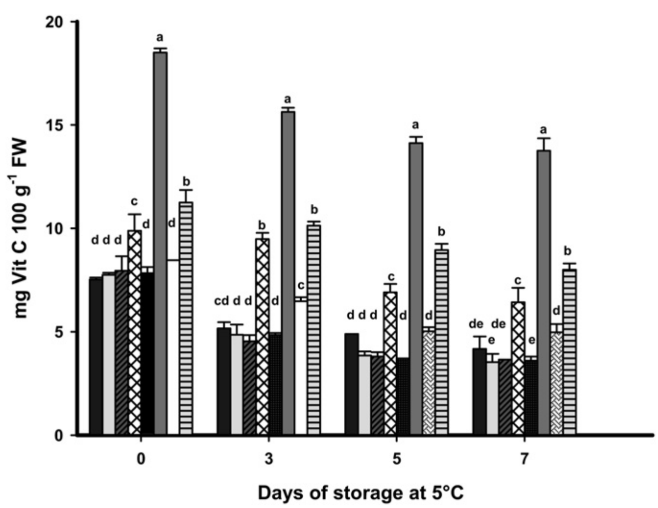

Fig. 2. Vitamin C (mg 100 g^{-1}) of fresh-cut melon combined or not with commercial and natural juices and stored under modified atmosphere packaging at 5 °C up to 7 days. Vertical bars indicate the standard error of the means ($n = 3$). Melon + pineapple juice; Melon + grape juice; Melon + apple juice; Melon + Galia juice; Melon + commercial melon juice; Melon + Cantaloupe juice; Melon + mango juice; Melon pieces. For each day of sampling, values followed by the same letter are not significantly different ($P \leq 0.05$).

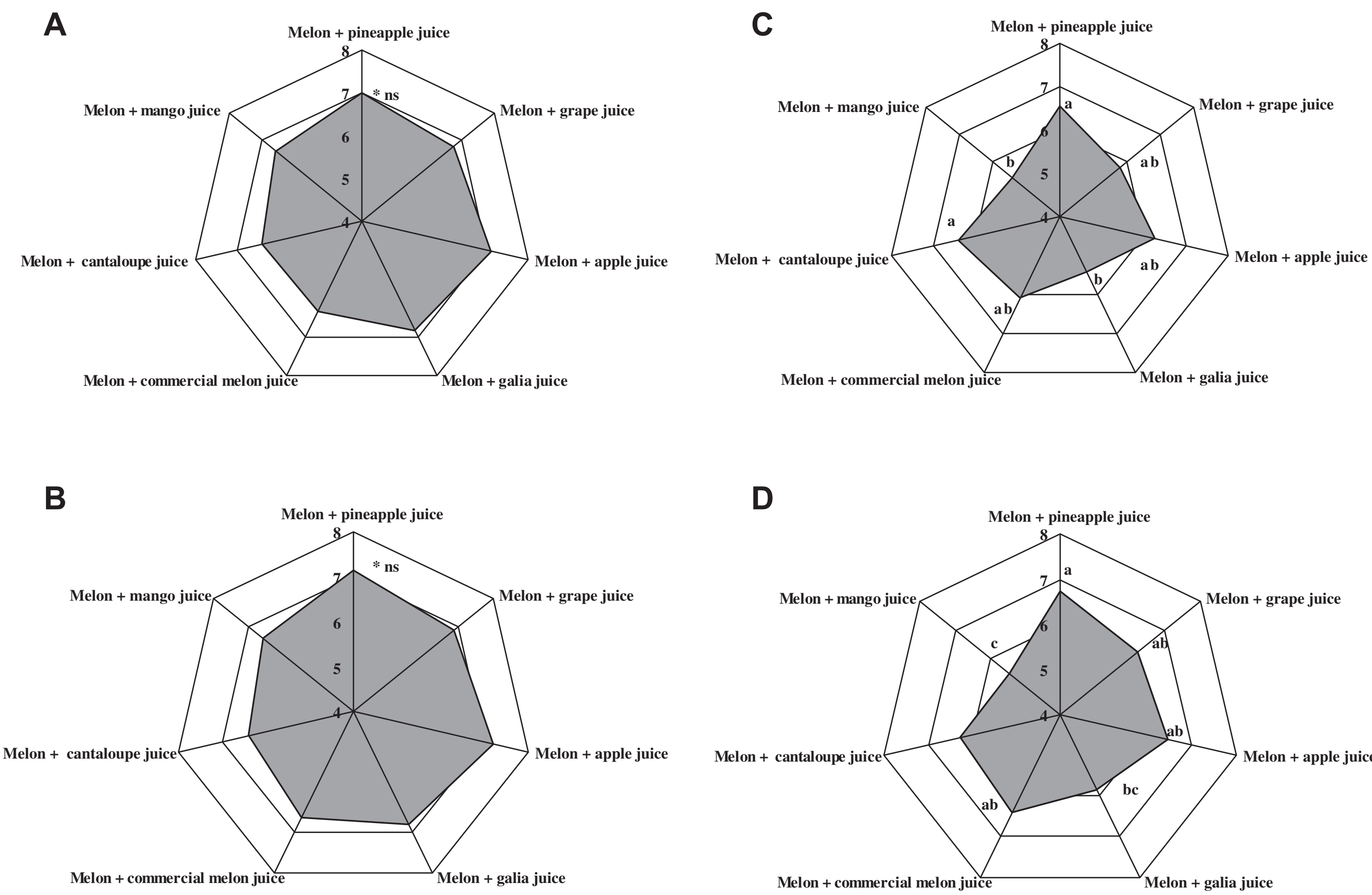

Fig. 3. Sensory evaluation ($n = 15$) of fresh-cut melon combined or not with commercial and natural juices and stored under modified atmosphere packaging at 5 °C at day 7. (A) External appearance (B) color (C) flavor (D) overall quality. Values followed by the same letter are not significantly different ($P \leq 0.05$). * ns: not significant.

It is well known that vitamin C, specially the AA, is by far the least stable nutrient during processing; it is highly sensitive to degradation that depends upon many factors such as oxygen, heat, light, storage temperature and storage time (Franke, Custer, Arakaki, & Murphy, 2004). In this sense, many studies have shown that it is a highly thermolabile compound easily degraded by the application of heat as mentioned by Plaza, Sánchez-Moreno, Elez-Martínez, de Ancos, Martín-Belloso & Cano (2006) who reported that the pasteurization treatment (90 °C for 1 min) determined an initial reduction of 17.2% on orange juice vitamin C, more severe than that the obtained in this work.

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

Initial differences on TSS values were found, where fresh-cut melon combined with commercial juices showed the highest values because these juices had sugar added during in the industrial elaboration process (Table 1). This fact was supported because no differences among melon pieces and melon pieces in Galia juice were registered. A reduction on TSS values occurred in all of the treatment after 7 days of storage, keeping the same initial trend. This behavior can be attributed to the metabolism of the fresh-cut melon. Melon pieces, by the fact of being alive, continue the respiration process, consuming sugars and varying TSS levels, as mentioned by Lamikanra, Chen, Banks & Hunter (2000), which reflect on sugar contents.

The pH values of the several treatments of melons and juices combinations showed initial statistical differences where the combination with natural juices presented the highest values (Table 1). At the end of the storage, a general increase in pH values, independently of the treatment, was observed and the initial trend was kept. As expected, melon pieces in natural juices showed the lowest TA. According to changes found in pH values, TA decreased over the storage period (Table 1). The decrease in TA was assumed to be due to respiration of melon pieces since organic acids are, with sugars, respiratory substrates.

Results from other researchers, for the above mentioned parameters in juices treated in diverse ways, show different trends. Contrary to our findings, Walkling-Ribeiro, Noci, Cronin, Lyng, and Morgan (2010) reported a decrease in pH values of different smoothies moderate heat treated (72 °C for 15 s) after 28 days of storage at 4 °C, that the authors attributed to an increased microbial activity. In this same work, TSS remained stable for 28 days. As the commercial juice used on this work had subjected to a previous industrial pasteurization process, it could be expected that pH, TA and TSS values remained constant. However, our juices were combined with fresh-cut melon which is an active matrix, with metabolic activity and able to transfer or receive organic compounds from the juices to obtain a steady state. This effect was greater in natural juices probably because the heat treatment applied was not severe enough to change the characteristics of the raw material from which they derive and no additive was added.

3.4. Sensory evaluation

Panelist did not perceive any significant difference in the appearance or color of the different mixtures of fresh-cut melon and juices, which were only affected by the time of storage (Fig. 3A and B). These parameters showed values of 7.06 and 6.91 respectively at the begging of the experiment (data not shown) and after 7 days at 5 °C, the medium values were 6.64 and 6.40 respectively. The largest differences found were observed on flavor and overall quality. The combinations of fresh-cut melon with Galia and mango juice obtained the lowest flavor score (5.42 and 5.43, respectively) at the end of the storage period (Fig. 3C) attributed to different causes. In the case of fresh-cut melon with Galia juice, consumers expressed an altered taste of the juice that turned it a little sour while in the fresh-cut melon with mango juice the low score was due to lack of flavor (insipid), compared with the remaining treatments. Although, in this experiment, the heat treatment in Galia juice was not as severe as pasteurization, it was sufficient to cause an important flavor alteration of the juice, although it did not alter the Cantaloupe juice. Heat treatment is mentioned as causing significant damages on the organoleptic, nutritional and physicochemical properties of fluid foods, being that the intensity of these alterations depends on factors such as matrix composition, temperature used, and exposure time amongst others (Elez-Martínez, Soliva-Fortuny, & Martín-Belloso, 2006). The differences in matrix composition could explain the fact that the sensory values of Galia juice were altered while the Cantaloupe was not.

The highest overall quality value was reached by fresh-cut melon in pineapple juice (6.73), with combinations of fresh-cut melon with Galia and mango juices the lowest values (5.8 and 5.58, respectively) linked to the mentioned above in relation to flavor (Fig. 3D). These low flavor scores, near the limit of rejection, casts doubt on the feasibility of their developing. The remaining combinations did not show significant differences, with values among 6.2 to 6.45. Within the works that evaluate the effect of heat treatment on the sensory quality of juices, Walkling-Ribeiro et al. (2010) compared untreated and moderate heat treated (72 °C for 15 s) fruit smoothie and determined no differences in color, odors, flavor and overall acceptability. Therefore, if heat treatments are not as severe, sensory quality of the products would not necessarily be affected.

4. Conclusions

Comparative overall evaluation of combinations of fresh-cut Galia melon and natural mild heat treated melon juices or with several commercial juices determined that both kinds of combinations as possible alternatives to the single fresh-cut product. The new products developed in the current work obtained a good quality having a higher added value than the single fresh-cut melon. As a consequence of their lower pH, the commercial juices used reduced microbial growth and would allow to extend the shelf-life of the combination. However, the combination of fresh-cut melon with Cantaloupe juice should be preferable because it showed a higher vitamin C content no added sugar, and a lower caloric intake, in line with healthy products. In order to extend the shelf-life period, the suggested combination should be acidulated with ascorbic or citric acid ensuring the microbiological safety.

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