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Minimal processing of pomegranate var. Wonderful

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SUMMARY – The effect of different types of semi-permeable films and antioxidant solutions on the quality of minimally processed pomegranate arils was evaluated during storage at 4°C±0.5 for 14 days. Colour changes were not observed and the browning was slight in all the treatments studied but highest on those without antioxidants. pH and acidity values remained constant and the soluble solids content increased only in the arils packaged in perforated polyethylene films due to the high dehydration. The CO₂ concentration inside the BB4 films reached 22%. The aerobic mesophiles count and moulds and yeast count were low in all the treatments and in the semi-permeable films a reduction was observed. The uses of semi-permeable films in minimally processed pomegranate arils allowed storage for 14 days, at 4°C±0.5, with good chemical, physical and microbiological quality.

Key words: Pomegranate, minimally processed, semi-permeable films, quality factors.

RESUME – "Transformation de quatrième gamme de la grenade var. Wonderful". L'effet de différents types de films semi-perméables et de solutions antioxydantes sur la qualité des arilles de grenade pour quatrième gamme a été évaluée lors du stockage à 4°C±0,5 pendant 14 jours. On n'a pas observé de changements de couleur et le brunissement a été léger dans tous les traitements étudiés mais était le plus fort dans ceux sans antioxydants. Les valeurs de pH et d'acidité sont restées constantes et la teneur en solides solubles a augmenté seulement dans les arilles emballés sous film de polyéthylène perforé dû à la forte déshydratation. La concentration en CO₂ dans les films de BB4 a atteint 22%. Le comptage de mésophiles aérobies et de moisissures et le comptage de levures ont été faibles dans tous les traitements et on a observé une réduction pour les films semi-perméables. L'utilisation de films semi-perméables pour les arilles de grenade en vue d'une transformation de quatrième gamme a permis le stockage pendant 14 jours, à 4°C±0,5, avec une bonne qualité chimique, physique et microbiologique.

Mots-clés : Grenade, transformation de quatrième gamme, films semi-perméables, facteurs de qualité.

Introduction

The pomegranate is a fruit tree of great adaptability to adverse climatic conditions, it is able to support severe colds, salinity soils, tolerate droughts and grow in semi-arid zones.

According to the last Agricultural Census (1997) in Chile, the current cultivated surface is 17.5 ha, mainly in the III and IV Regions; however, there are extensive semi-arid regions where it would be possible to cultivate it, which explains why this specie is acquiring importance again.

The fruit has a coriaceous rind whose colour could vary from yellow-greenish to intense red, the seeds surrounded by a sweet and juicy pulp (arils) correspond to the eatable portion and are separated by a white and astringent membrane. The Wonderful variety is well known in the world and is one of the most cultivated in Chile; the fruit is big, red, with a brilliant appearance, its peel thickness is moderate, arils are small, red and present a good juice yield with high soluble solids content, high acidity (classified as sweet and sour variety) and a dark red colour due to the high content of anthocyanins. For this reason, it is considered as a good variety for fresh consumption and also to be processed (Roy and Waskar, 1997).

The pomegranate is consumed mainly fresh, but the difficulty presented for peeling the fruit, has limited its consumption. The commercialisation of fresh arils minimally processed and "ready-to-eat", could be a good alternative for the national market.

The minimal processing consists in the washing with sanitizants agents to reduce the initial microbial count, pH modifications, use of antioxidants agents, temperature control and others, to control partially the high perishability of the fruits. On the other hand, the use of polymeric film packaging in order to develop a microcontrolled atmosphere, reduces the respiratory intensity and maintains unfavourable conditions for the action of many contaminating microorganisms.

Researches carried out in Spain by Gil *et al.* (1996a,b) on pomegranate minimally processed show a browning produced by the oxidation of the phenolic compounds during the storage, indicating that the stabilisation of anthocyanic pigments is essential in order to achieve a good quality. Gil *et al.* (1996b) determined in the Mollar variety that arils washed with chlorinated water and antioxidant solution, packed in polyethylene film and stored at 1°C, maintain a good quality and appearance in the fruit for 7 days, without visible attack of moulds. Hess-Pierce and Kader (1997) concluded that it is possible with Wonderful pomegranate arils to reach 16 days at 5°C with 20% gas composition of CO₂, without changes in the physical and chemical characteristics of the fruit; the arils with mechanical damage presented more susceptibility to the moulds after 12 days.

In Chile there is no research in pomegranate arils minimally processed and the objective of this first study was to evaluate the effect of semi-permeable films, and the use of an antioxidant mixture solution, in the shelf-life of minimally processed pomegranate arils stored at 4°C±1 for seven days or more.

Material and methods

For this study pomegranate var. Wonderful from Copiapó, 3rd Region of Chile, was used.

Two types of packaging films (both Cryovac, based on Ethyl Vinyl Acetate), with selective permeability characteristics to CO₂ and O₂ were used (Table 1) and, as a control, perforated polyethylene bags were used. Sodium hypochlorite (100 ppm) and a mixture of ascorbic acid and citric acid solutions (both to the 5% w/v) were used as sanitizing and antioxidant agents, respectively.

Table 1. Oxygen permeability of the used packaging materials

Film type	Oxygen (ml/m ² × d)
PE	3,900 - 13,000 (1 atm)
BB4	3 - 6 (1 atm, 5°C)
BE	4,600 (1 atm, 25°C)

Fresh fruit was characterised for weight, external colour, arils yield, weight and colour of the arils, soluble solids content (°Brix), pH, acidity (%) and visual browning.

The flow sheet (Fig. 1) used in the fruit processing included peeling the fruits carefully and manually at room temperature (10-12°C), eliminating arils with mechanical damage, then some arils were washed for immersion in a sodium hypochlorite solution (100 ppm) during 5 min and centrifuged (750 rpm for 5 min) and others drained, according to the treatment to be followed.

Table 2 shows the treatment applied to arils after being washed in chlorinated water, where some of them were dipped in the antioxidant solution for 30 s, centrifuged and packed (150 g of arils/bag).

Bags were sealed under a vacuum pressure (0.1 atm) using a Multivac A-NG 90131 machine. After, they were stored at 4°C±0.5 and 85% RH, for 14 days.

During the storage the gas composition was analysed on a HP 5890 II Series gas chromatograph at 3, 7, and 14 days and expressed in percentage of CO₂ and O₂. After 7 and 14 storage days, microbiological analysis (aerobic mesophiles total count, moulds and yeast) were done and also physical and chemical evaluations, to control the following: (i) *weight losses of the arils*, using a

Sartorius balance and expressed in percentage; (ii) *colour*, using the Nickerson Fan based on the Munsell Chart; (iii) *browning degree*, by visual appreciation and expressed in percentage of the total weigh of packed arils; (iv) *titrable acidity*, using a pHmeter Cole Parmer Mod. 5669-20, expressed in percentage of citric acid; (v) *pH*, measured in a pHmeter Cole Parmer; and (vi) *soluble solids*, using a Atago refractometer with automatic compensation of temperature, expressed in °Brix .

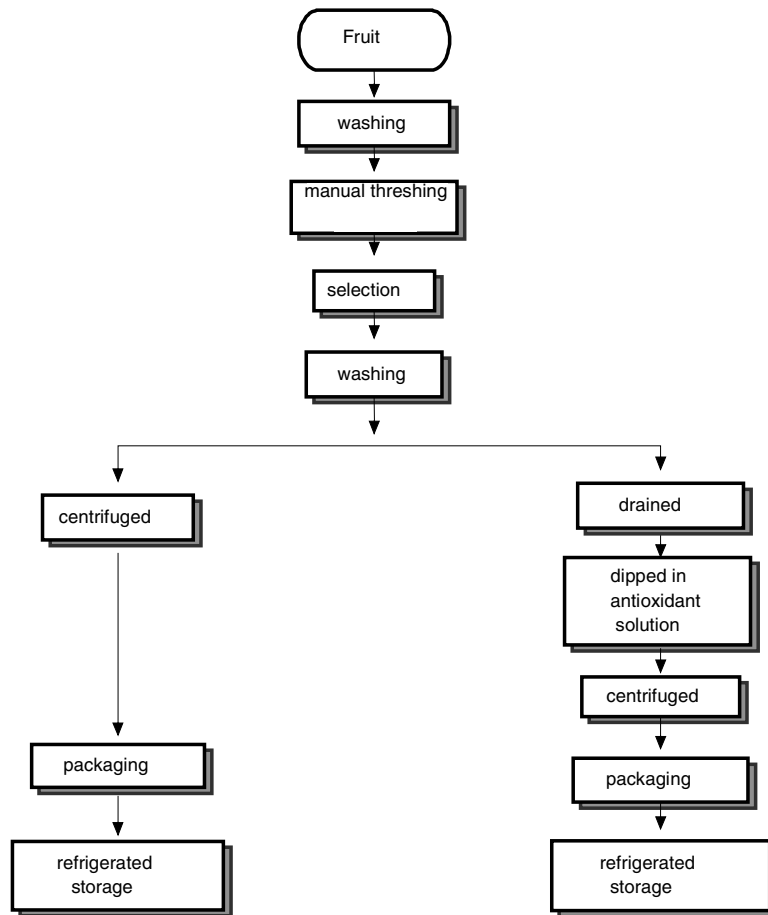


Fig. 1. Flow sheet for the minimum processing of pomegranate arils.

Table 2. Treatments applied to the arils

Treatment	Packaging type	Inmersion in
1	PE bag perforated	Chlorinated water
2	PE bag perforated	Chlorinated water and antioxidant solution
3	BB4 bag	Chlorinated water
4	BB4 bag	Chlorinated water and antioxidant solution
5	PE bag	Chlorinated water
6	PE bag	Chlorinated water and antioxidant solution

The experimental design was completely randomised with factorial structure 3×2, where the first factor corresponded to the three types of packaging material and the second factor was the use or not of antioxidant solution. The experimental unit was a package with 150 g of sample. Four repetitions for each treatment were carried out. The results were analysed by ANOVA and a Duncan Test was applied when significant differences existed.

Results and discussion

The average weight of the fruits used in this study was 425 g, corresponding 55.3% to rind and membranes and 44.7% to arils. The average weight of the arils was 0.33 g. The moisture average of the eatable portion was similar to the informed by E. Sepúlveda (pers. comm.) corresponding to 43.9% and inferior to the observed in the var. 'Española' of 62.8%. The chemical characteristics of the fruit were: pH 3.1, soluble solids content 15.8°Brix and 1.1% acidity (citric acid), soluble solids/acidity ratio was 14.3. Crisosto *et al.* (1996) reported as good maturity index for pomegranate an acidity in the juice inferior to 1.85%. The arils colour at the beginning of the study was intense red corresponding in the Nickerson Fan to 2.5R 3/7 on 75% of the arils, and 25% to 5R 4/12. Crisosto *et al.* (1996) considered as a good colour in the pomegranate juice that corresponding to 5R 5/12 or darker.

The initial microbiological analysis showed a low microbial count (65 cfu/g), previous to the wash and after being washed with chlorinated water and treated with antioxidant solution, mesophiles aerobic count decreased to 10 cfu/g and, on moulds and yeast, a decrease from 185 cfu/g to 5 cfu/g was observed.

During the refrigerated storage, the gases composition inside the BE and BB4 packages changed differently (Fig. 2). The concentration of O₂ decreased, reaching values close to 12% in treatments 5 and 6 (BE film) and to 1% in treatments 3 and 4 (BB4 film), at 14 days. The concentration of CO₂ remained practically constant at 2% in the treatments with BE film, while in the packages BB4, an increment of CO₂ to values close to 22% were observed. According to Gorny (1997), concentrations of CO₂ between 15 and 20% would be beneficial for the fruit, since a decrease in the growth of microorganisms takes place.

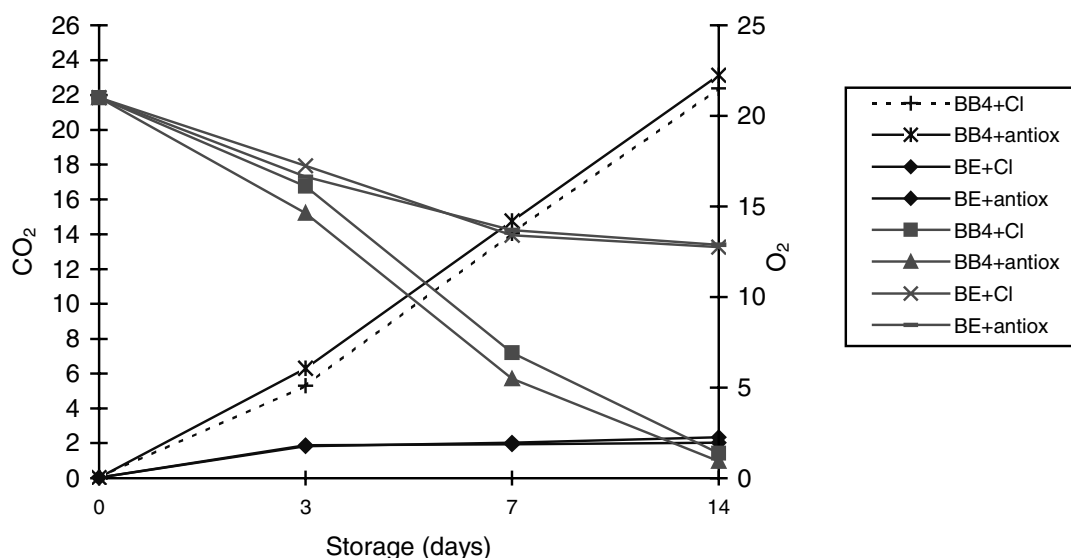


Fig. 2. Gases concentration in arils of pomegranate var. Wonderful.

The weight loss of arils, either at 7 days as well as at 14 days, was low in the treatments packaged in BE and BB4 film, showing significant differences with the PE bags (T1, T2), whose weight loss was 5.2 and 3.5% respectively; the other treatments presented loss of weight which fluctuated between 0.2 and 0.4%, which was not significant. Elyatem and Kader (1984) point out that the pomegranate is very susceptible to weight loss and should be stored at 95% RH or more, in order to minimise this problem. In this research, the semi-permeable packages used showed a positive effect in this point. The greater dehydration suffered by the arils on the perforated packages was reflected in a soluble solids content increase of both treatments.

It is important to note that the colour of the arils remained constant at 2.5R 3/7, according to the Nickerson Fan, corresponding to a "dark red" colour in all the treatments, in the observations carried out both at 7 and at 14 days.

The browning was in general low; at 7 days, none of the treatments exceeded a 0.5% of browning arils, observing differences between the treatments with and without antioxidants application, being significantly superior the browning in the treatments in which the arils were only washed with chlorinated water; while at 14 days, treatment 5, whose package (BE) is a more permeable film to the O₂ and without treatment with acids, presented a 2.5% of browning, followed by treatment 6 that used the same type of package, but was treated with acids, which presented a 1.7% of browning. Even though the browning values increased during the 14 days, this did not affect the general appearance of the product. Gil *et al.* (1996a) did not find differences in the stability of the pigments when washing with chlorine or chlorine and antioxidants; in this study, a positive effect of the antioxidants in the browning inhibition was observed.

The diverse treatments did not affect the pH values and in all of them a light decrease was observed, this was not significant with values between 2.92 and 2.98 after 14 days of storage.

In the soluble solids content, a significant increase was only observed at 7 and 14 days, in the treatments packed with PE (T1, T2) with values close to 17°Brix; this could be attributed to a greater concentration of solids due to the dehydration in this type of film. Packages BB4 and BE showed no differences during the storage. Crisosto *et al.* (1996) point out that the ideal for a good postharvest quality for the var. Wonderful, is a soluble solids content close to 17%.

No difference in the titrable acidity was observed for both treatments after 7 days; however, after 14 days, treatment 1 (PE bag and washed with chlorinated water), presented an acidity significantly higher than other treatments; this could be attributed to a light microbiological deterioration affecting some packages of this treatment.

The total count of mesophiles aerobics, as well as that of mould and yeast, was low during the whole period under study. After 7 days, only the treatments in perforated bag (PE) T1 and T2 showed an increment in the total count of mesophiles aerobics, being higher in T2; in the semi-permeable packages (BB4 and BE), treatments 3 and 5 (only washed with chlorinated water), a decrease in the number of colonies was observed. After 14 days, all the treatments with BB4 and BE packages showed a very low total count, which was inferior to that observed after 7 days and to the one observed at the initial count, which could be attributed to the higher concentration of carbon dioxide inside the packages, that influenced the bacterial development. According to Gorny (1997), with concentrations of CO₂ between 15 and 20%, a decrease in the growth of microorganisms takes place in the var. Wonderful.

Moulds and yeast show a minor development in the treatments including a wash with chlorinated water and immersion in antioxidant solution. This effect was observed for the three types of packages.

Conclusions

It is possible to conclude that the use of semi-permeable packages (BE and BB4), with or without application of antioxidant solution, allow storage of pomegranate arils var. Wonderful for 14 days at 4°C±0.5 with good physical and microbiological conditions for their commercialization.

The effect of the antioxidants, although low for the browning inhibition, was positive to reduce the population of spoilage organisms, especially moulds and yeast in the treated arils.

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