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EVALUATION OF THREE KINDS OF PACKAGING MATERIAL IN EDRANOL AVOCADOS (*Persea americana* Mill.) AS FRESH-CUT PRODUCTS

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To evaluate the effect of 3 kinds of packaging material on the quality of Edranol avocado as fresh-cut products, fruits of similar weight (200 and 250 g) with a percentage of oil 18- 20% were harvested and left to soften up to 1.84 k of pulp resistance to pressure. Later, the fruit was washed, peeled, cut, disinfected and subjected to antioxidant treatment, to be packed in 3 kinds of material (aluminum, polypropylene and low-density polyethylene) with modified atmosphere (5% of O_2 + 15% of CO_2 + 80% of N_2, with a 40% of void) and refrigerated at 3°± 1ºC and 90% RH for 0, 5, 10 and 15 days. In every storage period, pH, color and acidity were determined. Through a sensory evaluation panel, the parameters of taste, texture, color and presentation of the product were evaluated. The variables of color, chroma and hue, were affected by storage time, whereas pH did not vary. The polypropylene packaging kept taste, texture, color and presentation for a period of time longer than the polyethylene and aluminum packaging. The keeping life of the products using polypropylene packaging ranged from 9 to 11 days, while in the polyethylene and aluminum packaging from 5 to 7 days.

Key words: Quality, modified atmosphere, packaging, storage, antioxidants.

EVALUACIÓN DE TRES TIPOS DE MATERIAL DE ENVASE SOBRE PALTA (*Persea americana* Mill.) CV. EDRANOL, COMO PRODUCTO IV GAMA

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Para evaluar el efecto de 3 tipos de material de envase sobre la calidad de palta cv. Edranol en IV gama, se cosecharon frutos de peso homogéneo (200 y 250 g) con un porcentaje de aceite 18 - 20%, y se dejaron ablandar hasta 1.84 K de resistencia de la pulpa a la presión. Posteriormente, la fruta fue lavada, pelada, trozada, desinfectada y sometida a tratamiento con antioxidante, para ser envasada en 3 tipos de material (aluminio, polipropileno y polietileno de baja densidad) con atmósfera modificada (5% de O_2 + 15% de CO_2 + 80% de N_2, con un 40% de vacío) y refrigerada a 3 ± 1ºC y 90% HR por 0, 5, 10 y 15 días. En cada periodo de almacenamiento se midió: pH, color y acidez. Mediante un panel de evaluación sensorial, se evaluaron los parámetros**:** sabor, textura, color, olor y presentación del producto. El tipo de material y los tiempos de almacenamiento afectaron en conjunto la acidez y luminosidad (color) del producto. Las variables del color: croma y ángulo de tono, fueron afectados por el tiempo de almacenamiento, mientras que el pH no sufrió variación. El envase de polipropileno mantuvo por más tiempo el sabor, textura, color y presentación, con respecto a los envases de polietileno y aluminio. La duración del producto

usando el envase de polipropileno fue de 9 a 11 días, mientras que en los envases de polietileno y aluminio fue de 5 a 7 días.

Palabras clave: Calidad, atmósfera modificada, envases, almacenamiento, antioxidantes.

1. Introduction

Over the last two decades, minimally-processed products are one of the most important and significant technological innovations. Products from the fourth range (Nemesny, 2005) are included in this category.

Fourth-range products consist of horticultural and fruit products, mainly fresh, which have been washed, peeled, cut or presented entirely and placed in sealed packaging in modified atmosphere to be immediately consumed without preparation by the consumer (De Pablo and Reyes, 2004). This methodology is mentioned as one with the greatest development perspectives, where salads and sliced fruits are the most consolidated products within this group (Tomas, 1998; Sierra, 2004a; De Pablo and Reyes, 2004).

Gallardo (1996) and Ormazabal (1999), in tests conducted in halves of Hass, Edranol and Gwen avocados have determined levels from 2 to 5% of O_2 and 7 to 10% of CO_2 as suitable for the storage of these processed products.

Plastic films (laminated or coextruded) and flexible packs are amongst the main plastic films developed for the packing of processed products. Coextruded films (EVA, laminated aluminium) consist of a series of micro-perforated sheets simultaneously produced, which are subjected to a hot fusion without using adhesives (Cortez, 2004).

Flexible packs are plastic films characterised for having a high mechanical resistance to traction, perforation and low temperatures, in addition to presenting appropriate durability and sealability. Some of the main materials used for the elaboration of flexible packs are: High density polyethylene (HDPE), Polyvinyl chloride (PVC), Polypropylene and Polyamides (Cortez, 2004).

By having different properties, these packing materials would also show different behaviours in avocados processed as fourth-range products.

During the present trial, the effect of three types of packing material (Low-density polyethylene, polypropylene and aluminium) on the quality of Edranol avocado in modified atmosphere and cold storage was determined.

2. Materials and methods

Fruits of Edranol avocados were obtained from the Experimental Station La Palma of the Faculty of Agricultural Sciences, Pontificia Universidad Católica de

Valparaíso, located in the city of Quillota (Latitude 32° 49' S, Longitude 71° 16'W). Forty-eight fruits, between 200 and 350 g, with a maturity level of 18 – 20% oil were collected. To determine the maturity level, the methodology that correlates the moisture percentage with the oil percentage in the fruit (Olaeta and Undurraga, 1995).

Subsequently, the fruits were taken to laboratory, where they were let to soften at ambient temperature up to 1.84 k of pulp resistance to pressure (cone penetrometer 8 mm of diameter).

The process methodology was described by Sierra (2004). The avocados were washed and cooled with water at 5°C (41°F) in order to reduce the field temperature, then they were peeled using stainless-steel knife and cut lengthwise, discarding the seed, leaving the fruits in halves as a way of presentation.

After cutting them, the fruits were treated with chlorinated water (150 ppm of chlorine in solution) during 3 minutes. Subsequently, the fruits were washed with drinking water, leaving them drain for 5 minutes and then immersed in 3 L of a solution of ascorbic acid and citric acid, at 0.5% each for 10 minutes

The halves treated were placed in 15x20cm polystyrene trays placing on each 200 g (4 – 6 halves).

The trays, a total of 48, were divided into 3 equal groups and packed each in bags of 20 x 30cm made of: Aluminium, Low density polyethylene and Polypropylene respectively, whose properties are shown in Table 1.

The bags were subsequently sealed with a sealing-injecting machine WEBOMATIC EIO H-G modifying their atmosphere with a gaseous mixture that contained: 5% of O_2 + 15% of CO_2 + 80% of N_2 and then refrigerated at 3 ± 1ºC (37.4°F) and 90% RH for 0, 5, 10 and 15 days.

Table 1: Permeability characteristics of different materials used to pack minimally-processed products.

Material	**Permeability to water vapour** (1)	**Permeability to Oxygen** (2)	**Permeability to CO_2** (1)
Aluminium	40 – 60	125000	50000
Polypropylene	100 – 125	5000	18000
Low Density Polyethylene	18	7800	42000

Source: Parry (1995)
(1) Values expressed in g/m 2/24 h; at conditions of 38°C (100°F) and 90% humidity.
(2 Values expressed in en cm3/m2/24 h/atm, at 25ºC (77°F) and 25 microns thick.

In every storage period, the following was determined: pH (digital pH meter), colour (colorimeter MINOLTA CR-200; values expressed in CIElab modified by

Mc Guire, 1992) and acidity by titration. Through a sensory evaluation panel, the parameters of taste, texture, colour, odour and presentation of the product were evaluated.

A Completely Randomized Design with 3 x 4 factorial arrangement (three types of packaging material and four periods of refrigerated storage) with four replications per treatment, where the experimental unit is a bag with processed avocados.

The quantitative variables were analysed through the Tukey ($p \leq 0.05$) test and as well as the qualitative variables using the non-parametric Friedman test ($p \leq 0.05$).

3. Results and discussion

Regarding the acidity, the existence of an interaction between the types of packaging material used and the period of refrigerated storage (Table 2) was determined. The acidity reached, in the polypropylene packaging, the highest levels towards the end of the storage period, which may be caused by the effect of this material, keeping for a longer time the atmosphere surrounding the product, retarding the typical biochemical processes of maturity.

Regarding the pH, no effect of treatments was detected, possibly by the poor penetration of the antioxidant, by the short time remaining in solution. In addition, the high oil content in fruits due to the maturity level impedes the antioxidants to act better inside them. The above-mentioned coincides with results obtained by Gallardo (1996) in Edranol avocados, and Soliva-Fortuny, Oms-Oliu and Martin Belloso (2002) in Jonagold apples (Table 3).

Table 2: Interaction between the types of packaging material used and the period of storage on the acidity in Edranol avocados (halves)

TREATMENTS	**ACIDITY(g/100ml)**
Polyethylene / 0 days	0.01784 a
Polyethylene / 5 days	0.00788 e
Polyethylene / 10 days	0.00635 f
Polyethylene / 15 days	0.00458 g
Aluminium / 0 days	0.01784 a
Aluminium / 5 days	0.01591 b
Aluminium / 10 days	0.00828 e
Aluminium / 15 days	0.00699 ef
Polypropylene / 0 days	0.01784 a
Polypropylene / 5 days	0.01230 c
Polypropylene / 10 days	0.01150 cd
Polypropylene / 15 days	0.01037 d

Averages with the same letters in the same column do not show any significant differences according to Tukey's multiple comparison test (p=0.05).

Table 3: Effect of refrigerated storage period on the pH in Edranol avocados (halves)

STORAGE PERIOD (days)	pH
0	6.09 a
5	6.11 a
10	6.21 a
15	6.26 a

Averages with the same letters in the same column do not show any significant differences according to Tukey's multiple comparison test (p=0.05).

Regarding the components of colour, the luminosity was affected by the type of packaging and by the storage period (Table 4); however, chroma and hue were only affected by the storage period (Table 5).

All the treatments showed a loss of luminosity with regard to raw material; however, the aluminium packaging presented the lowest loss of luminosity over the other two types of packaging.

Table 4: Interaction between the types of packaging material and the period of storage on luminosity in Edranol avocados (halves)

TREATMENTS	LUMINOSITY (L)
Polyethylene / 0 days	72.275 a
Polyethylene / 5 days	72.425 a
Polyethylene / 10 days	61.775 d
Polyethylene / 15 days	50.575 f
Aluminium / 0 days	72.275 a
Aluminium / 5 days	71.8 a
Aluminium / 10 days	68.875 b
Aluminium / 15 days	65.775 c
Polypropylene / 0 days	72.275 a
Polypropylene / 5 days	69.925 ab
Polypropylene / 10 days	53.825 e
Polypropylene / 15 days	53.3 ef

Averages with the same letters in the same column do not show any significant differences according to Tukey's multiple comparison test (p=0.05).

This loss of luminosity is caused by the loss of atmosphere inside the packaging through time, which produces the typical darkening of the browning process in fruits. Gallardo (1996) determined different changes in colour according to variety and the type of atmosphere used, finding differences among cultivars Hass, Gwen and Edranol.

Table 5: Effect of period of refrigerated storage on the value of chroma and hue (H) in Edranol avocados (halves)

STORAGE PERIOD (days)	CHROME (C)	HUE (H)
0	44.92 a	66.14 a
5	44.88 a	65.43 a
10	43.68 a	63.24 a
15	41.04 b	54.04 b

Averages with the same letters in the same column do not show any significant differences according to Tukey's multiple comparison test (p=0.05).

Although chroma and hue are affected by a reduction in their levels, this is not significant, except in the last measurement, which is caused at the end of the period the metabolic processes that start the ripening process, changing the hue.

Girard and Lau (1995) observe that the change of colour establishes the end of the shelf life of products in sliced Jonagold apples.

Trials with halves of Edranol avocado establish that the colour losses are produced by low doses or bad penetration of antioxidants, which causes an increased browning level (Gallardo, 1996).

Regarding the sensory characteristics (Table 6), the taste of Edranol avocado halves on day 15 of cold storage, the packaging with polypropylene is different from the other 2 types of packaging, achieving to keep a good taste of the product until the end of the measurement.

Nevertheless, neither the type of packaging material nor the storage period affected texture, presentation (appearance), colour and odour of the product, which coincides with the papers by Ormazabal (1999); Arze, (1993); Soliva-Fortuny, Oms-Oliu and Martín-Belloso, (2002); Sierra (2004) and Nemesny (2005) that indicate the physical appearance (presentation and colour) of the Fourth Range products suffers minimal variations for until a period of 7 to 10 days, provided that the balance of the atmosphere inside the packaging is not affected.

These results are mainly obtained from a process of fermentative metabolism typical of living tissues, which start with the senescence process, together with a loss in the quality of taste, odour and colour of the fruits (Day, 2001).

Table 6: Effect of different types of packaging material and refrigerated storage period on taste, texture, presentation, colour and odour in Edranol avocados (halves)

TIPO DE ENVASE	Day 0	Day 5	Day 10	Day 15	Day 0	Day 5	Day 10	Day 15
	TASTE				**TEXTURE**			
Polyethylene (control)	4.50 a	4.40 a	4.20 a	3.70 b	4.00 a	3.75 a	3.98 a	3.10 a
Polypropylene	4.50 a	4.34 a	4.30 a	3.82 a	4.00 a	4.15 a	3.90 a	3.18 a
Aluminium	4.50 a	4.20 a	4.02 a	3.58 b	4.00 a	3.95 a	3.90 a	3.00 a
	APPEARANCE				**COLOUR**			
Polyethylene (control)	4.00 a	4.15 a	3.98 a	3.26 a	4.00 a	3.75 a	3.68 a	2.20 a
Polypropylene	4.00 a	4.15 a	4.10 a	3.10 a	4.00 a	3.81 a	3.74 a	2.45 a
Aluminium	4.00 a	4.08 a	4.00 a	2.95 a	4.00 a	3.58 a	3.61 a	2.30 a
	ODOUR							
Polyethylene (control)	3.00 a	3.00 a	3.00 a	2.75 a				
Polypropylene	3.00 a	3.00 a	3.00 a	2.70 a				
Aluminium	3.00 a	3.00 a	2.85 a	2.52 a				

For each evaluation, values followed by the same letter in the same column are not statistically different according to the Friedman non-parametric test (p= 0.05).
1. Very unpleasant; 2. Unpleasant; 3. Regular; 4. Pleasant; 5. Very pleasant

4. Conclusions

1. Aluminium, low-density polyethylene and polypropylene packaging for halves of Edranol avocados, in fourth range, with a modified ambient of 5% O_2 + 15% CO_2 + 80% N, stored at 3 ± 1ºC (37.4ºF), increase the acidity and reduce luminosity of the product until 15 days of storage.

2. Polypropylene packaging generates the highest level of acidity, while the aluminium causes the lowest loss in terms of luminosity in halves of Edranol avocados until 15 days of storage.

3. The variables of colour, chroma and hue angle in Edranol avocado are reduced with the storage time, when stored for 15 days in fourth range at 3 ± 1ºC (37.4ºF).

4. Avocado halves from Edranol cultivar, packaged in fourth range with polypropylene material keep for a longer time the taste, texture, colour and presentation compared to low-density polyethylene or aluminium packaging.

5. Halves of Edranol avocados, packaged with 5% O_2 + 15% CO_2 + 80% N, semi-processed in fourth range and packaged in polypropylene, keep their organoleptic

conditions as acceptable during 11 days, whereas those in low-density polyethylene and aluminium packaging do not exceed 7 days.

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