

EFFECT OF RIPENESS AND REFRIGERATED STORAGE TEMPERATURES ON THE CONSERVATION OF ISABEL AVOCADO

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In Isabel avocado fruits, the effect of 2 ripeness stages in harvest (13 – 15% and 15.1 – 17% oil) and 2 storage temperatures [6°C (43°F) and 8°C (46°F)], with 80 – 90% of relative humidity for 15, 30 and 45 days was evaluated. In every storage period, the following was determined: weight loss, pulp resistance to pressure, color, physiological disorders and pathological damages. Later, the fruit was left to soften at 12°C (54 °F) up to 1.81 kg of pressure, where palatability was determined through a sensory evaluation panel. The storage period above 30 days increased the weight loss, physiological and pathological damages, and change of epidermis color. The sensory panel determined that fruits harvested between 13 – 15% oil and kept for a storage period up to 30 days, at 8°C (46°F), show the best characteristics of palatability.

Key words: quality, weight losses, physiological disorders, pathological damages, sensory evaluation.

EFFECTO DE LA MADUREZ Y TEMPERATURAS DE ALMACENAMIENTO REFRIGERADO SOBRE LA CONSERVACIÓN DE PALTAS CV. ISABEL

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En frutos de palta del cv. Isabel, se evaluó el efecto de 2 estados de madurez a cosecha (13 – 15% y 15,1 – 17% de aceite) y 2 temperaturas de almacenamiento (6 y 8° C), con 80 - 90% de humedad relativa, por 15, 30 y 45 días. En cada período de almacenamiento se midió: pérdida de peso, resistencia de la pulpa a la presión, color, desórdenes fisiológicos y daños patológicos. Posteriormente, la fruta se dejó ablandar a 12° C hasta 1.81 Kg de presión, donde se midió, mediante panel de evaluación sensorial, la palatabilidad. El período de almacenamiento superior a 30 días, incrementó la pérdida de peso, daños fisiológicos, patológicos y viraje en el color de la epidermis. El panel sensorial determinó que frutos cosechados entre 13 – 15% de aceite, por un periodo de almacenamiento hasta 30 días, a una temperatura de 8° C, presentan las mejores características de palatabilidad.

Palabras clave: calidad, Pérdidas de peso, Desórdenes fisiológicos, Daños patológicos, Evaluación sensorial.

1. Introduction

In the search of new avocado varieties at the Faculty of Agricultural Sciences from Pontificia Universidad Católica de Valparaíso, researches have been conducted on a new cultivar named Isabel, which has interesting characteristics for both consumers and growers. This cultivar characterises its fruits by changing from green to black as well as higher resistance to cold, reaching suitable oil levels for its harvest in a period shorter than that of Hass (Zúñiga, 1998).

The size of the fruit of the Isabel variety is medium to large, somewhat egg-shaped on its maturity stage and its skin is deep green, turning into purple black similar to that of Hass variety. Its average weight is 300 g. It has a yellow yellowish-green pulp. Its texture is quite soft; and its taste is rated as pleasant and very similar to Hass (Zúñiga, 1998).

The harvest season is long, starting approximately at the end of July, and finishing at the end of January (Zúñiga, 1998). Preliminary trials show that the Isabel variety is able to endure temperatures below 3°C (37.4°F); therefore, it could be recommended for low-temperature zones in which the planting of Hass is not possible (Zúñiga, 1998).

Regarding the behaviour in storage of Isabel variety, Guajardo (2002), working with avocados with 15% oil, achieved keeping the quality for 25 days, storing the fruit at $6 \pm 1^{\circ}\text{C}$ ($42.8 \pm 33.8^{\circ}\text{F}$). However, the proper maturity stage for harvesting the fruit and the suitable temperature for storing the Isabel avocados are still unknown.

In addition, several authors (Bravo, 1997; Undurraga and Olaeta, 1995; Dixon *et al.*, 2003), working with Hass avocados, have accomplished 40-day periods of refrigerated storage at 6 to $8 \pm 1^{\circ}\text{C}$ (42.8 to $46.4 \pm 33.8^{\circ}\text{F}$), achieving commercialisation periods above 5 days. In Fuerte avocados, temperatures between 5 to $8 \pm 1^{\circ}\text{C}$ (41 to $46.4 \pm 33.8^{\circ}\text{F}$) allow extending the post-harvest life for a period of 2 to 4 weeks.

In the present trial, the effect of temperature and storage period on the preservation and organoleptic quality of Isabel avocados was determined for two maturity stages.

2. Materials and methods

Isabel avocado fruits were obtained from 8-year-old trees of the Experimental Station La Palma of the Faculty of Agricultural Sciences, Pontificia Universidad Católica de Valparaíso, located in the city of Quillota (Latitude $32^{\circ} 49' \text{ S}$, Longitude $71^{\circ} 16' \text{ W}$).

Eight trees, with approximately 80 fruits per each, of the Isabel variety grafted on Mexicola rootstock, were marked.

Two trials were carried out: the first one with fruit having 13 and 15% oil and the second with 15.1 to 17% oil (A.O.A.C 1980).

The fruit from each maturity stage (144 fruits for each) was harvested, taken to laboratory, placed in boxes and divided for each trial into two equal groups of 72 avocados; where the first group was stored at $6 \pm 1^\circ\text{C}$ and the second one at $8 \pm 1^\circ\text{C}$, with 85 – 90% of relative humidity for 15, 30 and 45 days.

For every storage period, in each trial, the following was determined when leaving the chamber: weight loss (electronic balance PRECISA 3100C), pulp resistance to pressure (cone penetrometer 8 mm diameter, EFFEGI), colour of pulp and skin [colorimeter MINOLTA CR-200 and with values expressed in CIE Lab and modified according to Mc Guire (1992)], physiological disorders (visual evaluation, using an arbitrary scale from 1 to 5 where 1 = no damage; 2 = damage on the adjacent zone of the seed; 3 = damage < 25% of the pulp; 4 = damage in 25-50% pulp; 5 = damage > 50% pulp); and pathological damages (visual evaluation, presence-absence). Subsequently, the fruit was left to soften at ambient temperature until 1.8K of PRP, where, through a sensory evaluation panel formed by 6 judges, the following was measured: taste, internal appearance, external appearance and texture through a hedonic scale from 0 (very unpleasant) to 8 (very pleasant).

In both trials, a completely randomized design was used for the quantitative variables with a 2 x 3 factorial arrangement (temperature and time of storage) and in the case of differences among the treatments, the Tukey mean separation test ($p \leq 0.05$). Four replications per treatments were used, with 6 avocados as experimental unit.

For the qualitative variables the non-parametric Friedman test was applied ($p \leq 0.05$).

3. Results and discussion

For both trials a significant effect of the storage period was observed on the weight loss and pulp resistance to pressure, but not of the temperature and interaction between both factors. For the weight loss, the values are similar to those obtained for other cultivars by Peralta, (1977); Videla (1993) and Figueroa, (1994). However, it is noticed that in the trial with more advanced maturity (15.1-17% oil), the fruit showed on day 45 a slightly higher weight loss, although without affecting the quality. Regarding the pulp resistance to pressure, the fruits were able to endure it up to 30 days of storage, drastically decreasing after that period (Table 1).

Table 1: Effect of storage on weight loss (%) and pulp resistance to pressure (PRP) of Isabel avocado fruits with 13-15% and 15.1 - 17% oil

Maturity	Refrigerated storage		
	15 days	30 days	45 days
Weight loss (%)			
13-15%	1.86 a	4.27b	5.66c
15.1-17%	2.16a	3.51b	7.33c
PRP (k)			
13-15%	12.0 a	12.0 a	6.0 b
15.1-17%	12.0 a	12.0 a	5.5 b

Different letters in the same column show significant differences with $p \leq 0.05$ according to Tukey Test.

An effect of the storage period was only detected for the colour variable, in both skin and pulp, for both trials, but not of the temperature and interaction between both factors for the colour components evaluated. For the skin, the variables measured decrease during the storage, especially on day 45, since the skin changes to a darker colour. For the pulp, the variables measured are not especially affected during the storage, excepting luminosity in trial 1 (13-15% oil) which is reduced; however, all indicate one colour, yellowish-green pulp (Table 2).

Table 2: Effect of storage period on luminosity, chroma and hue in skin and pulp of Isabel avocado fruits harvested with 13-15% and 15.1-17% oil

Maturity	Skin			Pulp		
	Refrigerated Storage			Refrigerated Storage		
	15 days	30 days	45 days	15 days	30 days	45 days
Luminosity				Luminosity		
13-15%	30.28 a	27.33 b	21.93 c	70.95 a	74.14 a	57.70 b
15.1-17%	26.73 a	22.88 b	18.91 c	47.14 a	41.14 a	35.46 a
Chroma				Chroma		
13-15%	16.2 a	16.9 a	13.7 b	45.27a	41.35 a	33.47 a
15.1-17%	17.3 a	20 a	14.4 b	42.14 a	41.14 a	35.46 a
Hue				Hue		
13-15%	43.4 a	38.9 a	17.3 b	66.44 a	66.98 a	60.03 a
15.1-17%	62.94 a	48.2 b	28.8 c	68.20 a	61.66 a	65.65 a

Different letters in the same column show significant differences with $p \leq 0.05$ according to Tukey Test.

The incidence of physiological damages in both trials was minimal, only being mostly noticeable on day 45 of storage (Table 3).

Table 3: Effect of temperature and period of refrigerated storage on the incidence of internal browning in Isabel avocado fruits, stored at 6 and 8 °C with maturity level of 13 – 15% and 15.5 – 17% oil

TEMPERATURE	Storage period		
	15 days	30 days	45 days
13 -15% oil			
6°C	1.0	2.0	2.3
8°C	1.0	1.0	3.0
15.1-17% oil			
6°C	1.0	1.0	2.7
8°C	1.0	1.0	3.3

1 = no damage; 2 = damage on the adjacent zone of the seed; 3 = damage < 25% of the pulp; 4 = damage in 25-50% pulp; 5 = damage > 50% pulp

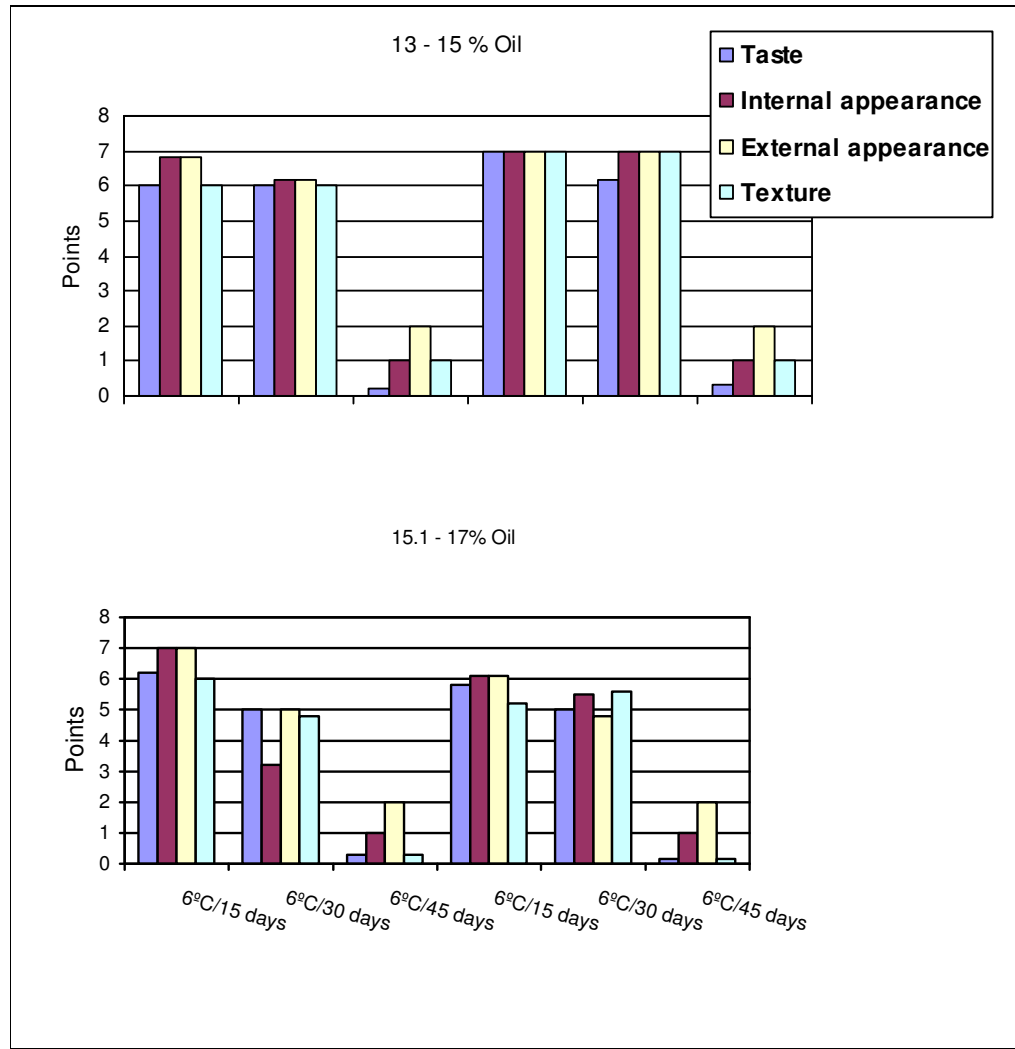
For both trials, it is noticed that the fruit presented on day 45 of storage a slight internal browning. In trial 1, it is also observed that the fruit stored at 6± 1°C showed on day 30 of storage a browning around the seed, damage not noticed in the fruit stored at 8°C. This may occur since temperature has, at this maturity level, an incidence on physiological disorders related to cold-caused damages, mainly given by a less-advanced maturity (Eaks, 1976; Vorster and Toerien, 1990).

Table 4 shows that the fruits, only as of day 45 of storage and at both temperatures, presented in both trials symptoms of soft rot and dark brown colour, which developed from the periphery towards the internal part of the fruit, signs of the *Fusicoccum* sp. fungus.

Table 4: Effect of temperature and period of refrigerated storage on the occurrence of physiological damages in Isabel avocados fruits, stored at 6± 1°C and 8± 1°C with a maturity level of 13 – 15% and 15.5 – 17% oil

TEMPERATURE	Storage period		
	15 days	30 days	45 days
13 -15% oil			
6°C	no	no	yes
8°C	no	no	yes
15.1-17% oil			
6°C	no	no	yes
8°C	no	no	yes

According to the sensory evaluation panel (Figure 1) for both trials, the variables of taste, internal appearance, external appearance and texture would be negatively affected when exceeding the 30 days of storage in both trials.



0 =very unpleasant; 8= very pleasant

Figure 1: Sensory analysis, internal appearance, external appearance and texture of Isabel avocados stored at $6 \pm 1^\circ\text{C}$ and $8 \pm 1^\circ\text{C}$ with a maturity level of 13 – 15% and 15.5 – 17% oil.

In trial 1 (13 – 15% oil), the sensory properties measured were kept in better conditions than in trial 2 (15.1 – 17% oil), up to 30 days of storage, for both temperatures, being the fruits stored at $8 \pm 1^\circ\text{C}$ in better conditions.

4. Conclusions

Isabel fruit harvested with 13-15% and 15.1-17% oil keep a good quality during the refrigerated storage up to 30 days of storage, at $6 \pm 1^{\circ}\text{C}$ and $8 \pm 1^{\circ}\text{C}$.

Isabel fruit harvested with 13-15% and 15.1-17% oil lose less than 8% of weight in 45 days of refrigerated storage at $6 \pm 1^{\circ}\text{C}$ and $8 \pm 1^{\circ}\text{C}$.

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