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Effects of Peeling, Film Packaging, and Cold Storage on the Quality of Minimally Processed Prickly Pears (*Opuntia ficus-indica* L. Mill.)

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Abstract: *Opuntia* species exhibit beneficial properties when used to treat chronic diseases, particularly obesity, diabetes, cardiovascular disease, and cancer; however, the presence of spines and glochids in the species' skin that easily stick into consumers' fingers has limited their consumption. For this study, white and orange *Opuntia ficus-indica* fruits from the Canary Islands (Spain) were minimally processed, packed in a passive atmosphere, and stored at 7 °C. The effects of peeling (by hand or with an electric peeler) and two micro-perforated films (90PPlus and 180PPlus) were evaluated. Changes in the quality parameters, gas composition, bioactive compounds, sensory features, and microbial safety of fresh-cut prickly pears were examined during 10 days of cold storage. Both varieties, hand-peeled and electrically peeled, were microbiologically safe (aerobic mesophiles < 7 log(CFU/g fresh weight)) and retained suitable nutritional quality after 8 days of storage. The yield was greater when fruits were electrically peeled than hand-peeled (70.7% vs. 44.0% and 66.5% vs. 40.8% for white and orange fruits, respectively). The concentrations of oxygen and carbon dioxide were above 15% and below 7.5%, respectively, in all the treatments over the shelf life. TSS decreased during storage independently of variety, peeling method, or film. Fructose was the most abundant sugar, followed by glucose and sucrose. The electric peeling machine improved not only the edible part of the fruit but also the contents of bioactive compounds, such as ascorbic acid and phenolic compounds.

Keywords: fresh-cut; electric peeling; gas composition; tray; micro-perforated film

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Citation: Díaz-Delgado, G.L.; Rodríguez-Rodríguez, E.M.; Dorta, E.; Lobo, M.G. Effects of Peeling, Film Packaging, and Cold Storage on the Quality of Minimally Processed Prickly Pears (*Opuntia ficus-indica* L. Mill.). *Agriculture* **2022**, *12*, 281. https://doi.org/10.3390/agriculture12020281

Academic Editor: Bengang Wu

Received: 17 December 2021
Accepted: 11 February 2022
Published: 16 February 2022

1. Introduction

Opuntia fruit, also known as cactus pear fruit, prickly pear, tuna (Mexico), higo (Colombia), higo chumbo (Spain), and figue de barbarie (France), is harvested from various species of the genus *Opuntia* of the cactus family (Cactaceae). The fruit is a xerophyte, producing about 200–300 species, mainly growing in arid and semi-arid zones, and it is produced and consumed in several countries. The most important species producing edible fruit are *O. ficus-indica*, *O. robusta*, *O. streptacantha*, *O. amyclaea*, *O. megacantha*, and *O. hiptiacantha* [1]. It is native to Mexico and was introduced to Europe by the Spanish conquerors, and the Canary Islands was the first non-American territory where it was planted at different altitudes, thus enabling the extension of the commercialization period from the end of June to February [2].

Opuntia is a fruit with high contents of fiber, minerals, vitamins, and antioxidant compounds with functional properties for preventing chronic diseases [3–7]. A few studies have shown that the phytochemicals from *O. ficus-indica* help control hypoglycemic, hypolipidemic, and hypocholesterolemic diseases and are neuroprotective [8]. Moreover, a recent study confirmed that the antioxidants from red, orange, and white prickly pear varieties from the Canary Islands remain stable while traveling through the gastrointestinal tract and can be easily absorbed by the human body [9]. The presence of glochids together with spines on the fruit´s surface [10] is a great disadvantage that limits its intake and commercialization in comparison to other fruits. On the other hand, modern consumers are increasingly demanding healthy and ready-to-eat products. Taking advantage of this opportunity, the prickly pear could be minimally processed (fresh-cut) to potentially increase its consumption and open new alternatives for its commercialization. The preparation of minimally processed fruits includes washing, peeling, disinfecting, packaging, and cold storing [11]. These processes cause increases in enzyme activity and the acceleration of physiological reactions, thus promoting microbial growth [12], which is usually the parameter that limits commercialization [13]. The use of bio-materials [14], surface coatings, calcium salt applications, modified atmosphere packaging, gamma radiation, and cold storage are the most used approaches used for quality retention to minimize nutritional losses, sensorial losses, and microbial growth [15]. In fact, under these conditions, one can obtain products with similar characteristics to fresh products with a shelf life of 7–10 days such as pineapple [16], kiwifruit [17], mango [18], and lychee [19].

Peeling is an extremely important step because it exposes large surface areas to air, leading to water loss, oxidation, and microorganism attacks. Moreover, peeling is usually performed by hand, thus increasing the final value of the minimally processed product. However, few studies have compared manual and mechanical peeling. Many processing innovations and automations are being implemented to reduce the amount of manual peeling in order to increase production yields [20–22]. The main factors that affect the peeling process are the mechanical and physical properties of fruit and vegetable tissues, such as skin thickness, firmness, toughness, variety, rupture force, cutting force, maximum shearing force, shear strength, tensile strength, and rupture stress [21,23]. Additionally, the peel obtained in this process is a by-product source of dietary fiber and bioactive compounds [24] that can be used to improve the profitability of manufacturing companies as a novel step in its sustainable utilization. Djeghim et al. [25] and Parafati et al. [26] reported that the use of various by-products, including prickly pear peel and prickly pear seed peel, improved the dough rheology and nutritional properties of bread. Furthermore, Morshedy et al. [27] reported that low levels of prickly pear cactus peel supplementation in the diet of lactating ewes improved the ewes' productive performance and growth, as well as the physiological status of their offspring.

The present study was aimed to cultivate ready-to-eat prickly pears with a shelf life of at least one week using simple and cheap hurdle technologies (mechanical peeling, micro-perforated films, and cold storage).

Our process flow diagram will be accessible for small and medium agro-industries to revalue this fruit in the Canary Islands and other countries in which its consumption is diminishing. Thus, manufacturers can promote the product while assuring its hygienic, nutritional, and sensorial qualities.

2. Materials and Methods

2.1. Plant Material, Sample Preparation, Packaging and Storage

Prickly pears (*O. ficus-indica* L. Mill.) were collected from a farm located in Buenavista, Tenerife, Spain (28°22′13″ N, 16°51′1″ W, 127 m above sea level) in December 2018. Two types of prickly pears of different colors were selected: white and orange. The white prickly pears were bigger and had thicker pericarps than the orange ones. We harvested 30 kg of both white (W) and orange (O) prickly pears, locally known as "Ariquero" and "Colorado", respectively, in the same fashion as other non-climacteric fruits when fully ripe to ensure good flavor quality and without any damage caused by decay-causing pathogens. Figure 1 shows the process flow diagram for obtaining the minimally processed prickly pears.

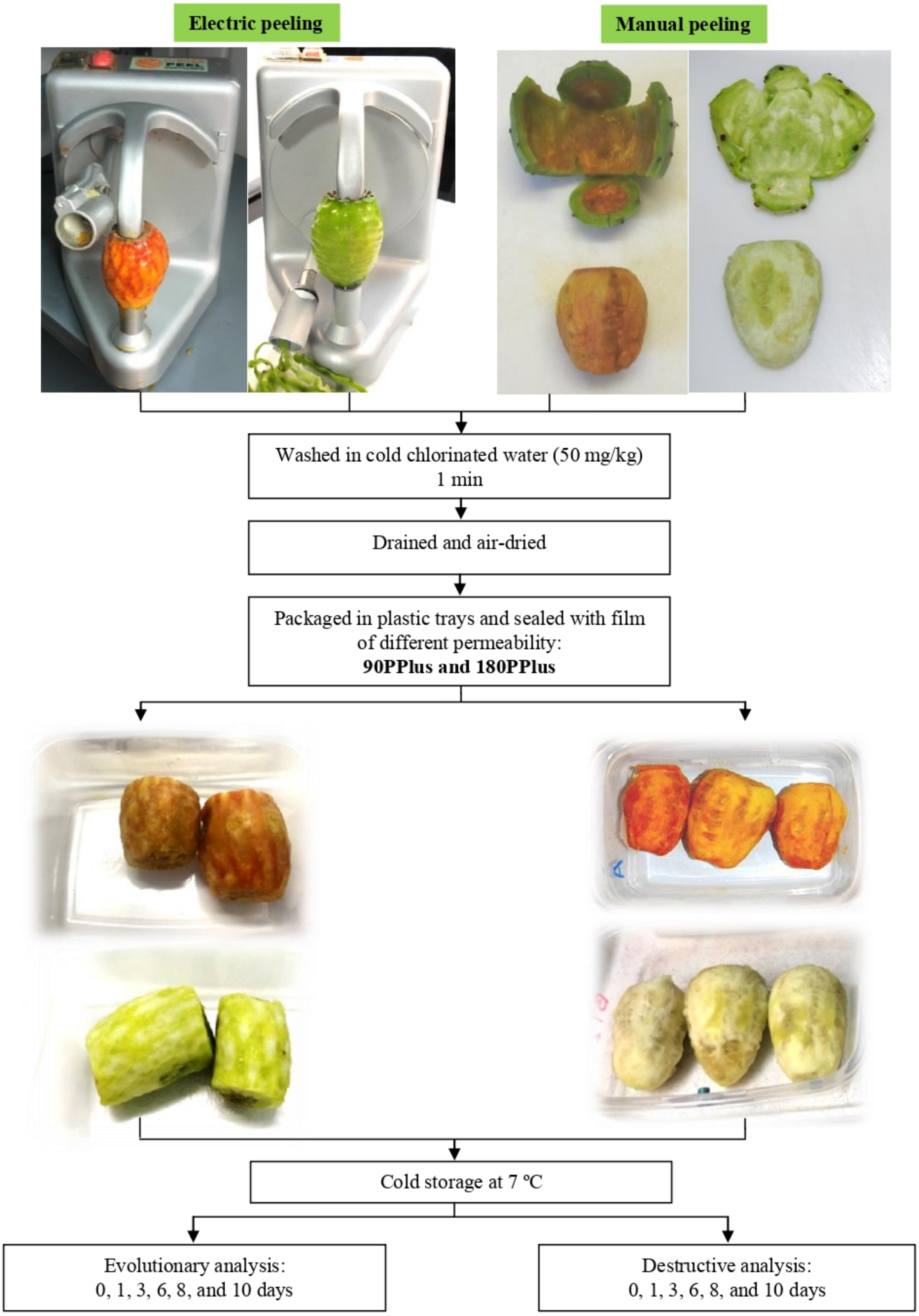


Figure 1. Process flow diagram for obtaining minimally processed prickly pears.

Fruits were washed with cold chlorinated water (200 mg/kg, pH 6.5–7.5) for 5 min and then air-dried. After washing and drying, the fruits' distal parts were removed and then peeled either by hand with a knife (H) or with an electric peeler machine (P) (Orange Peel, Pelamatic S.L, Valencia, Spain). The main difference between both peeling methods was the amount of pericarp eliminated in the process; the peel and the whole pericarp were removed in the fruits peeled with the knife (which is how it is traditionally performed by consumers; Figure 1), and the electric peeler only removed the peel (Figure 1).

Then, the peeled fruit was washed for 1 min in cold chlorinated water (50 mg/kg) before being packaged in groups of 2 or 3, depending on size, in plastic trays (polypropylene, 172 × 130 × 50 mm, supplied by Technopak Plastics S.L., Barcelona, Spain), and sealed using a heat-sealing machine (Efaman, Efabind S.L., Murcia, Spain) with a micro-perforated film (polypropylene, 52 µm, supplied by Amcor Flexibles, Burgos, Spain) of different permeability:

- Plastic 90PPlus, with low number of micro-perforations (90P) (permeability to O_2 and CO_2 of 5200 mL m^{-2} day^{-1} atm^{-1}).
- Plastic 180PPlus, with high number of micro-perforations (180P) (permeability to O_2 and CO_2 of 19,200 mL m^{-2} day^{-1} atm^{-1}).

A total of 104 trays of each variety were prepared and stored at 7 ± 1 °C; they were analyzed at the beginning of experiment and after 1, 3, 6, 8, and 10 days of storage (Figure 1).

Samples were labeled as follows: WH90P = white prickly pear, hand-peeled, packaged in 90PPlus film; OH90P = orange prickly pear, hand-peeled, packaged in 90PPlus film; WH180P = white prickly pear, hand-peeled, packaged in 180PPlus film; OH180P = orange prickly pear, hand-peeled, packaged in 180PPlus film; WE90P = white prickly pear, electrically peeled, packaged in 90PPlus film; OE90P = orange prickly pear, electrically peeled, packaged in 90PPlus film; WE180P = white prickly pear, electrically peeled, packaged in 180PPlus film; and OE180P = orange prickly pear, electrically peeled, packaged in 180PPlus film.

2.2. Technological Parameters

In order to calculate the technological parameters to determine the yield in a minimal processing industry, the following parameters were measured or calculated using 20 fruits: the whole weight, peel (residue), and edible portion. Peeling time was measured for both peeling methods and varieties, and it is expressed as the mean value of the 20 fruits in seconds. The yield of each peeling method was calculated by the following expression:

$$\text{Yield } (\%) = \left(\frac{\text{EP}}{\text{AP}}\right) \times 100$$

EP: Weight of the product after being peeled;
AP: Weight of the product as purchased.

2.3. Microbiological Analysis

Aerobic mesophiles, psychrophiles, and mold and yeast loads were evaluated to ensure microbial safety. Three trays from each treatment were analyzed in triplicate at each storage time. Six grams were homogenized in 54 mL of 0.1% peptone water (Sigma-Aldrich, Barcelona, Spain) using a homogenizer (Stomacher 80 Biomaster, Seward Limited, Worthing, United Kingdom). The serial dilutions were prepared from this original solution and finally inoculated in triplicate. Aerobic mesophiles and psychrophiles were inoculated in plate count agar (PCA) and then incubated at 30 °C for 72 h and 5 °C for 7 days, respectively, and molds and yeasts were inoculated in Glucose Chloramphenicol Agar (GCA) and incubated at 25 °C for 5 days. Microbial load is expressed as colony-forming units per gram (CFU/g) and compared with the values established by the Spanish legislation regarding minimally processed vegetables [28].

2.4. Sensorial Evaluation

Sensory evaluation was carried out by 15 panelists, who were regular consumers of prickly pears, in order to evaluate whether they were able to appreciate differences between hand-peeled (traditional method) and electrically peeled prickly pears. The number of panelists was similar to that reported by other authors [16,29–31].

Six fruits from each treatment were evaluated in terms of color, smell, taste, and overall acceptability using a linear scale from 0 (non-acceptable) to 10 (very acceptable) points. Additionally, panelists described the fruits' color (pale, normal/bright, or brown), sweetness (tasteless, normal, or very sweet), smell (unpleasant, normal, or pleasant), and texture (hard, normal, or slimy). Finally, they were asked whether they would buy the product. The trays were kept at room temperature for approximately half an hour before the tasting and opened just before it. Fruits were cut into slices between 0.5 and 1 cm thick. Three slices of each type of prickly pear were placed on plastic plates with a white background, labeled with random numbers, and served in an isolated and illuminated area at room temperature (20 °C) individually for each taster. Likewise, an unopened tray of each type was placed in the room so that the tasters could evaluate the general appearance of the packaged prickly pear. Panelists were also instructed to drink some water to rinse their palates between each sample [32].

2.5. Gas Composition

The gas composition (% CO_2 and % O_2) was determined using a compact PBI Dansensor Checkmate 9900 (Madrid, Spain), the needle of which was fed through the septum fixed on the unopened trays.

2.6. Physico-Chemical Analyses

Physico-chemical analyses were carried out for unopened trays (evolutionary analyses) and for opened trays (destructive analyses).

Color parameters (L, a*, and b*) were measured through the button of the transparent tray with a Minolta Chroma Meter CR-300 (Wheeling, WV, USA). From these data, the following parameters were calculated: hue angle (H°), chroma (C*), total color difference (ΔE), and whiteness index (WI) [33]. Thus, five trays from each treatment were analyzed in triplicate during cold storage.

$$H^\circ = \tan^{-1}(b^*/a^*)$$

$$C^* = [(a^*)^2 + (b^*)^2]^{0.5}$$

$$WI = 100 - [(100 - L^*)^2 + (a^*)^2 + (b^*)^2]^{0.5}$$

$$\Delta E = [(L^* - L^*_i)^2 + (a^* - a^*_i)^2 + (b^* - b^*_i)^2]^{0.5}$$

In addition, three trays from each treatment were opened at each storage time, and the following parameters were analyzed in triplicate: texture (N·s/g fresh weight) using a Kramer cell (TA-HD-Plus, Aname, Madrid, Spain) to simulate chewing and hardness (expressed as °Durofel) using a durometer (Durofel, Agro-Technologie, Tarascon, France).

Finally, samples of each treatment were minced and homogenized for analysis in triplicate. Moisture was determined with the oven-drying method (P Selecta 207, Barcelona, Spain), dry matter was calculated by difference [34] (AOAC 934.06), total soluble solids (TSS) were determined using a hand refractometer (ATC-1, ATAGO, Tokyo, Japan) [20] (AOAC 932.12), pH was measured with an automatic titrator (Titralab AT1000, Germany) [34] (AOAC 981.12), and total acidity (percentage citric acid) was determined via titration with NaOH to an endpoint of pH 8.1 [20] (AOAC 942.15).

2.7. Bioactive Compounds and Antioxidant Capacity Analysis

All analyses were performed in triplicate. Ascorbic acid content was volumetrically determined with a 2,6-dichlorophenol indophenol reagent [34] (967.21). Total phenolic content (TP) is expressed as milligrams of gallic acid equivalents (GAE) per 100 g of fresh weight (f.w.) and was analyzed with a Folin–Ciocalteu assay after the extraction of 1 g of pulp with 10 mL of 80% methanol. In the same extract, the antioxidant capacity was determined using the free radical DPPH (2,2-diphenyl-1-picryl hydrazyl) [35], and the results are expressed as milligrams of Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) equivalents (TE) per 100 g of f.w. Sugar contents were determined via high-performance liquid chromatography (HPLC) [36], with a Waters 2690 HPLC module equipped with a differential refractive index detector (Waters Corporation, Millford, MA, USA), using a Waters Carbohydrate Analysis column (3.9 × 300 mm) and acetonitrile/water (80:20) as the mobile phase. The content of each sugar is expressed as grams per 100 g of f.w.

2.8. Statistical Analysis

Data were analyzed using SPSS version 25.0 (SPSS Inc., Chicago, IL, USA) with a one-way ANOVA (Duncan's multiple range) in homogeneous groups established by the dependent variable (peeling, film type, and color of prickly pear), assuming significant differences when $p < 0.05$.

2.9. Ethical Statements

All subjects gave informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Brazilian Ethics Committee under number 845,894/2014.

3. Results and Discussion

The white prickly pears were bigger and heavier than the orange ones (140 vs. 87 g, respectively) (Figure 1). The yield was greater when fruits were electrically peeled: 70.7% (WE) versus 44.0% (WH) and 66.5% (OE) versus 40.8% (OH). The times needed by one of the regular consumer panelists to peel the white and orange prickly pear were 11.9 and 8.7 s, respectively, and the times needed by the peeler were 15.1 and 12.4 s, respectively. However, it was found to be faster to use the electric peeler to produce 1 kg of edible pulp for both varieties (214 s (WE) and 186 (OE) vs. 270 s (WH) and 213 (OH)). Thus, e.g., the production in a food processing company of 1000 trays of 250 g per day will need an operator working for 15 and 13 h using an electric peeler or 19 and 15 h using a knife for peeling white and orange prickly pears, respectively.

Moreover, electric peeling has more advantages because factory workers can operate more than one machine at the same time. In fact, using the same example, time can be reduced by 3 times when the operator places three fruits in three peelers (3 h for (WE) and 4 h for (OE)) or by 4 times (4 h for (WE) and 3 h for (OE)) when using four, which would increase company profits.

3.1. Microbiological Analysis

WE and OE presented significantly higher aerobic mesophile loads than WH and OH once prepared and after 8 days of cold storage, regardless of the type of film used, except for the white prickly pear with the 90PPlus film (Table 1). Psychrophilic values were generally higher when prickly pears were electrically peeled than those of hand-peeled pears until the 6th storage day. On the 8th day, only OE90P showed significantly higher values than the hand-peeled pears. The presence of mold and yeast was greater in orange prickly pears from day 3 than in white prickly pears. After 8 days of storage, WH showed higher levels of these microorganisms than WE under both films, and in orange prickly pear, OH90P had higher ($p < 0.05$) mold and yeast counts than OE90P.

Differences were detected in the growth of microorganisms depending on the film used (Table 1). Thus, the mesophile load was higher ($p < 0.05$) in the samples packed with 90PPlus film for WE, and it was higher in WH (except for the 8th day) and OE (from the 1st day) samples packed with the 180PPlus film. The WE and OH samples packed with 180PPlus film showed higher psychrophile loads, and the OH samples with the 90PPlus film showed significantly higher mold and yeast counts than those with the 180PPlus film. Likewise, significant increases were observed in all microorganisms´ loads over time, regardless of color, peeling type, and film used. Nevertheless, the number of aerobic mesophiles in both white and orange prickly pear varieties were within the limits (7 log(CFU/g fresh weight)) regulated in Spain for ready-to-eat fruits and vegetables by the Real Decreto 3484/2000 [28] from the day of preparation until day 8 of cold storage.

Likewise, the counts of psychrophilic bacteria, molds, and yeasts were below 6 log(CFU)/g in all the treatments from the preparation until day 8 of storage (Table 1). Cefola et al. [37] detected an increase in mesophile and psychrophile growth after 13 days of storage when prickly pears were packed in a passive modified atmosphere, and the growth was higher when they were stored at 8 °C compared to 4 °C. Their final values were similar to our data. Furthermore, Palma et al. [38] and Piga et al. [12] reported a remarkable proliferation of microorganisms during storage time.

Table 1. Evolution of aerobic mesophiles, psychrophiles, and mold and yeast in white and orange minimally processed prickly pears manually or electrically peeled and packed in two films of different permeability during cold storage at 7 °C.

	Storage Period (Days)				
	0	**1**	**3**	**6**	**8**
	Aerobic mesophiles log(CFU/g f.w.)				
WH90P	2.1 ± 0.1 ^{a,1}	2.5 ± 0.1 ^{b,1}	2.9 ± 0.0 ^{c,1}	3.8 ± 0.1 ^{d,1}	4.6 ± 0.0 ^{e,2}
WH180P	2.1 ± 0.1 ^{a,1}	3.9 ± 0.1 ^{b,3}	4.0 ± 0.0 ^{c,3}	4.0 ± 0.0 ^{c,2}	4.4 ± 4.4 ^{d,1}
WE90P	2.8 ± 0.2 ^{a,2}	3.8 ± 0.1 ^{b,3}	4.0 ± 0.0 ^{c,3}	4.3 ± 0.0 ^{d,3}	4.7 ± 0.1 ^{e,3}
WE180P	2.8 ± 0.2 ^{a,2}	3.5 ± 0.1 ^{b,2}	3.6 ± 0.1 $^{b\text{-}c,2}$	3.7 ± 0.1 ^{c,1}	4.5 ± 0.0 ^{d,2}
OH90P	2.3 ± 0.1 ^{a,1}	3.0 ± 0.0 ^{b,2}	3.4 ± 0.1 ^{c,2}	4.8 ± 0.0 ^{d,3}	4.1 ± 0.0 ^{e,1}
OH180P	2.3 ± 0.1 ^{a,1}	2.8 ± 0.1 ^{b,1}	3.5 ± 0.2 ^{c,2}	4.0 ± 0.2 ^{d,2}	4.6 ± 0.0 ^{e,2}
OE90P	2.8 ± 0.1 ^{a,2}	3.4 ± 0.0 ^{b,4}	3.2 ± 0.1 ^{c,1}	3.8 ± 0.1 ^{d,1}	4.7 ± 0.0 ^{e,3}
OE180P	2.8 ± 0.1 ^{a,2}	3.1 ± 0.1 ^{b,3}	4.1 ± 0.0 ^{c,3}	5.1 ± 0.1 ^{d,4}	5.4 ± 0.0 ^{e,4}
	Psychrophiles log(CFU/g f.w.)				
WH90P	1.4 ± 0.1 ^{a,1}	1.8 ± 0.1 ^{b,2}	2.3 ± 0.1 ^{c,1}	5.5 ± 0.1 ^{d,1}	5.7 ± 0.0 ^{e,1}
WH180P	1.4 ± 0.1 ^{a,1}	1.6 ± 0.1 ^{b,1}	2.2 ± 0.2 ^{c,1}	5.5 ± 0.0 ^{d,1}	5.7 ± 0.0 ^{e,1}
WE90P	2.1 ± 0.0 ^{a,2}	2.7 ± 0.0 ^{b,3}	3.8 ± 0.0 ^{c,2}	5.5 ± 0.1 ^{d,1}	5.7 ± 0.0 $^{e,1\text{-}2}$
WE180P	2.1 ± 0.0 ^{a,2}	3.9 ± 0.1 ^{b,4}	4.5 ± 0.1 ^{c,3}	5.6 ± 0.0 ^{d,2}	5.8 ± 0.0 ^{e,2}
OH90P	2.1 ± 0.1 ^{a,2}	2.1 ± 0.1 ^{a,1}	2.8 ± 0.1 ^{b,1}	5.2 ± 0.1 ^{c,1}	5.4 ± 0.0 ^{c,1}
OH180P	2.1 ± 0.1 ^{a,2}	2.5 ± 0.1 ^{b,3}	3.4 ± 0.0 ^{c,2}	5.4 ± 0.0 ^{d,2}	5.6 ± 0.0 $^{e,2\text{-}3}$
OE90P	1.7 ± 0.0 ^{a,1}	3.2 ± 0.1 ^{b,4}	3.3 ± 0.0 ^{c,2}	5.6 ± 0.0 ^{d,3}	5.7 ± 0.0 ^{e,3}
OE180P	1.7 ± 0.0 ^{a,1}	2.2 ± 0.0 ^{b,2}	3.7 ± 0.1 ^{c,3}	5.7 ± 0.0 ^{d,4}	5.6 ± 0.0 ^{e,2}
	Mold and yeast log(CFU/g f.w.)				
WH90P	1.9 ± 0.1 ^{a,1}	2.2 ± 0.1 ^{b,2}	2.3 ± 0.0 ^{c,1}	3.9 ± 0.0 ^{d,2}	4.7 ± 0.0 ^{e,1}
WH180P	1.9 ± 0.1 ^{a,1}	2.1 ± 0.0 ^{b,2}	2.3 ± 0.0 ^{c,1}	3.6 ± 0.1 ^{d,1}	4.7 ± 0.0 ^{e,2}
WE90P	2.0 ± 0.0 ^{a,1}	2.0 ± 0.0 ^{a,1}	2.8 ± 0.1 ^{b,3}	3.9 ± 0.1 ^{c,2}	4.7 ± 0.0 ^{d,2}
WE180P	2.0 ± 0.0 ^{a,1}	2.0 ± 0.0 ^{a,1}	2.5 ± 0.0 ^{b,2}	3.9 ± 0.0 ^{c,2}	4.8 ± 0.0 ^{d,3}
OH90P	2.0 ± 0.1 ^{a,2}	2.8 ± 0.0 ^{b,3}	2.9 ± 0.0 ^{c,2}	4.2 ± 0.0 ^{d,2}	5.2 ± 0.0 ^{e,4}
OH180P	2.0 ± 0.1 ^{a,2}	2.0 ± 0.1 ^{a,2}	2.8 ± 0.0 ^{b,1}	3.9 ± 0.0 ^{c,1}	5.1 ± 0.0 ^{d,2}
OE90P	1.8 ± 0.1 ^{a,1}	1.8 ± 0.1 ^{a,1}	3.0 ± 0.0 ^{b,3}	4.1 ± 0.1 ^{c,2}	5.2 ± 0.0 ^{d,3}
OE180P	1.8 ± 0.1 ^{a,1}	1.8 ± 0.1 ^{a,1}	3.2 ± 0.0 ^{b,4}	4.2 ± 0.0 ^{c,2}	5.0 ± 0.0 ^{d,1}

Hand-peeled (H) and electrically peeled (E) white (W) and orange (O) prickly pears packaged in 90PPlus (90P) and 180PPlus (180P) film. Different letters in a row indicate that there were significant differences between storage days ($p < 0.05$), and different numbers in a column indicate that there were significant differences between samples ($p < 0.05$).

3.2. Sensorial Evaluation

The panelists detected differences in the appearance, color, flavor, and odor at the beginning (0 days) in both prickly pear varieties, reporting higher mean values for the hand-peeled fruits ($p < 0.05$) (Table 2). No significant differences were detected in the sensory attributes at other storage times or between film packaging types.

Table 2. Mean values of the sensory attributes at the beginning.

	Initial Storage Time			
	Appearance	**Color**	**Flavor**	**Odor**
WH	7.5 ± 1.1 [2]	6.7 ± 0.5 [1]	7.7 ± 1.0 [2]	7.0 ± 1.4 [2]
WE	6.3 ± 0.5 [1]	7.3 ± 0.5 [2]	6.5 ± 0.8 [1]	5.8 ± 0.8 [1]
OH	8.3 ± 0.8 [2]	8.3 ± 0.5 [2]	8.5 ± 0.8 [2]	7.5 ± 1.1 [2]
OE	5.7 ± 0.8 [1]	6.5 ± 0.8 [1]	5.3 ± 0.8 [1]	5.7 ± 0.8 [1]

Hand-peeled (H) and electrically peeled (E) white (W) and orange (O) prickly pears. Different numbers in a column indicate that there were significant differences between samples ($p < 0.05$).

In general, as shown in Figure 2, tasters slightly preferred the manually peeled prickly pears to the electrically peeled ones (7.1 and 6.5 on a 10-point scale, respectively), regardless of the studied variety. WH under both packaging films at any storage time were those with the highest purchase percentages (between 75% and 100%), and the electrically peeled pears (especially those packed in 180PPlus film) were the most rejected by the tasters (only 33.3% would buy them) after 8 days of storage.

The acceptance of the minimally processed fruit did not decrease with storage time. The variable that negatively influenced the product rejection was texture, specifically when the panelists found the fruit too slimy or hard.

3.3. Gas Composition

Figure 3 shows a clear drop in the O_2 concentration and an increase in the CO_2 concentration of all the trays during cold storage, trends that were more pronounced for those sealed with 90PPlus film.

Thus, according to the film permeability, regardless of the variety and peeling method, the trays with either white or orange prickly pears packed in 180PPlus film (more micro-perforated) presented higher O_2 values and lower CO_2 values than those packed in 90PPlus film (less micro-perforated). Likewise, the accumulation of CO_2 inside the trays was greater in the OE for both packing films (90P and 180P), although these differences were not significant. Allegra et al. [39], Cefola et al. [37], and Piga et al. [12] detected significant increases and decreases ($p < 0.05$) in CO_2 and O_2 concentrations, respectively, during cold storage depending on the used film.

3.4. Physico-Chemical Analyses

3.4.1. Color

Color parameters (L, a*, and b*) were measured through the bottom of the same transparent trays during the study (Table 3).

L values were higher in white prickly pear trays than orange ones. The WE treatment led to a higher brightness (L) than the WH treatment; in the orange pears, these differences were only appreciated from day 6 in the OE180P sample. The orange prickly pears had higher a* values than the white ones, and they behaved differently during shelf life. However, the a* value increased with storage time in white prickly pears but decreased in orange pears, with only OE90P showing significantly different values. The type of peeling influenced the a* values shown by white prickly pears more than those shown by orange ones. Ultimately, WH presented a* values higher than WE during shelf life (Table A1, Appendix A). The b* parameter showed different trends depending on the studied prickly pear variety; WE showed higher values ($p < 0.05$) than those peeled manually (WH). In the orange variety from the first storage day, the highest and lowest b* values were detected in OE180P and OH90P, respectively. In addition, this parameter seemed to considerably fluctuate in the white variety during storage time, especially in WE180P, while remaining more or less constant in the orange ones, especially in OE180P (Table A1, Appendix A). The tonality (H°) decreased with storage time in the white prickly pears and remained more or less constant in the orange ones. In general, WE showed higher H° values than WH, and its trend in orange pears was similar to that described for the b* parameter. The orange variety showed lower H° values than the white variety. The type of film had little influence on the L, a*, b*, and H parameters. Electrically peeled white prickly pears showed higher chromaticity (C*) values than those peeled by hand at each storage time independently of the film used; this fact was not observed in the orange variety. Allegra et al. [39] found reported unremarkable changes in flesh color occurring during the summer storage or late, freshly cut prickly pears that were harvested either at commercial harvest time or when fully ripe.

Table 3. Color parameters of white and orange minimally processed prickly pears that were manually or electrically peeled and packed in two films of different permeability during cold storage at 7 °C.

	Storage Period (Days)				
	0	1	3	6	8
			L		
WH90P	53.9 ± 3.9 a,1	51.5 ± 1.9 a,1	49.6 ± 0.9 a,1	54.7 ± 3.5 a,1	53.3 ± 2.1 a,1
WH180P	56.7 ± 3.0 b,1-2	52.2 ± 0.6 a,1	52.5 ± 1.9 a,2	53.4 ± 2.7 a,1	51.9 ± 0.9 a,1
WE90P	60.0 ± 3.2 b,2	55.1 ± 2.1 a,2	56.5 ± 1.9 a,3	62.3 ± 1.6 b,2	61.3 ± 3.4 b,2
WE180P	56.2 ± 1.3 a,1-2	59.7 ± 1.7 b,3	59.9 ± 2.8 b,4	60.6 ± 3.2 b,2	61.7 ± 3.1 b,2
OH90P	38.5 ± 2.1 a,1	39.7 ± 2.3 a,1	41.3 ± 2.1 a,1	41.1 ± 4.3 a,1	41.5 ± 5.0 a,1
OH180P	40.9 ± 4.0 a,1	41.3 ± 3.3 a,1	41.0 ± 1.8 a,1	43.4 ± 2.7 a,1	43.7 ± 2.5 a,1
OE90P	41.2 ± 2.4 a,1	38.4 ± 1.5 a,1	41.0 ± 2.4 a,1	45.0 ± 5.4 a,1	44.5 ± 4.8 a,1
OE180P	41.2 ± 3.2 a,1	42.0 ± 3.4 a,1	44.2 ± 3.1 a-b,1	47.7 ± 2.6 b-c,1	49.7 ± 1.9 c,2
			H° (HUE)		
WH90P	110 ± 5.7 a,1	111 ± 4.7 a,1	109 ± 4.2 a,1	109 ± 3.2 a,1	105 ± 4.4 a,1
WH180P	111 ± 2.2 b,1	111 ± 1.1 b,1	110 ± 2.6 b,1	108 ± 2.1 b,1	106 ± 1.2 a,1
WE90P	115 ± 3.0 c,1	114 ± 1.9 b-c,1-2	114 ± 2.2 b-c,2	111 ± 2.5 a-b,1	109 ± 1.7 a,1
WE180P	115 ± 1.7 c,1	116 ± 1.1 c,2	114 ± 1.9 b-c,2	112 ± 1.4 b,1	108 ± 2.2 a,1
OH90P	47.1 ± 10 a,1	41.7 ± 7.1 a,1	40.1 ± 9.5 a,1	40.4 ± 6.9 a,1	40.8 ± 5.9 a,1
OH180P	46.3 ± 6.5 a,1	43.4 ± 3.4 a,1	43.0 ± 6.9 a,1	46.1 ± 8.2 a,1	46.8 ± 9.7 a,1-2
OE90P	46.6 ± 4.7 a,1	41.7 ± 6.6 a,1	45.5 ± 8.4 a,1	46.7 ± 9.4 a,1	46.8 ± 11 a,1-2
OE180P	61.2 ± 12 a,2	52.0 ± 5.9 a,2	52.7 ± 13 a,1	57.9 ± 14 a,1	59.8 ± 11 a,2
			C*		
WH90P	17.7 ± 3.6 a,1	15.0 ± 3.4 a,1	13.6 ± 3.7 a,1	18.3 ± 4.1 a,1	18.0 ± 3.9 a,1
WH180P	15.7 ± 3.1 b,1	11.8 ± 2.2 a,1	13.5 ± 2.3 a-b,1	16.0 ± 2.3 b,1	16.1 ± 1.2 b,1
WE90P	26.7 ± 3.0 b,2	22.2 ± 3.1 a,2	23.2 ± 1.9 a-b,2	25.7 ± 3.7 a-b,2	27.1 ± 2.2 b,2
WE180P	22.8 ± 2.2 a,2	23.6 ± 3.1 a,2	24.3 ± 2.9 a,2	25.8 ± 2.8 a,2	28.6 ± 4.0 a,2
OH90P	28.0 ± 3.4 b,1	21.0 ± 4.9 a,1	20.6 ± 3.7 a,1	19.9 ± 5.2 a,1	20.7 ± 4.9 a,1
OH180P	26.0 ± 5.7 a,1	26.5 ± 1.8 a,1	24.7 ± 2.2 a,1	23.8 ± 4.2 a,1	22.3 ± 1.7 a,1
OE90P	36.2 ± 3.1 b,2	20.1 ± 3.8 a,1	21.2 ± 4.9 a,1	24.7 ± 2.3 a,1	22.4 ± 2.1 a,1
OE180P	23.1 ± 4.9 a,1	26.0 ± 5.2 a,1	24.2 ± 4.6 a,1	25.0 ± 1.6 a,1	24.9 ± 2.2 a,1
			ΔE		
WH90P		5.81 ± 2.1 b,1	6.16 ± 0.9 b,1	4.70 ± 1.2 a-b,1	3.20 ± 0.3 a,1
WH180P		5.44 ± 1.3 a,1	5.32 ± 3.8 a,1	5.69 ± 1.1 a,1	6.49 ± 1.6 a,2-3
WE90P		7.08 ± 1.8 a,1	6.67 ± 2.3 a,1	5.85 ± 1.6 a,1	5.60 ± 2.7 a,1-2
WE180P		4.40 ± 1.2 a,1	4.90 ± 1.4 a,1	6.47 ± 1.4 a-b,1	8.43 ± 2.3 b,3
OH90P		8.38 ± 1.3 a,1	7.82 ± 1.6 a,2	9.46 ± 2.3 a,1	9.26 ± 3.0 a,1
OH180P		6.46 ± 4.0 a,1	6.65 ± 2.1 a,1-2	8.45 ± 5.0 a,1	8.98 ± 3.7 a,1
OE90P		14.7 ± 1.9 a,2	15.0 ± 2.9 a,3	16.6 ± 0.7 a,2	17.7 ± 0.6 a,2
OE180P		6.17 ± 0.9 a-b,1	4.90 ± 0.9 a,1	7.48 ± 1.3 b-c,1	8.14 ± 1.2 c,1
			WI		
WH90P	50.4 ± 2.6 a,1	49.1 ± 1.1 a,1	47.7 ± 1.0 a,1	51.0 ± 2.2 a,1	49.7 ± 1.4 a,1
WH180P	53.9 ± 3.2 b,1	50.6 ± 0.4 a,1	50.5 ± 1.4 a,1-2	50.7 ± 2.1 a,1	49.3 ± 0.9 a,1
WE90P	51.8 ± 3.0 a,1	49.8 ± 1.4 a,1	50.7 ± 1.8 a,1-2	54.3 ± 2.1 a,1	52.8 ± 3.5 a,1
WE180P	50.6 ± 1.5 a,1	53.3 ± 1.9 a,2	53.1 ± 3.5 a,2	52.8 ± 3.4 a,1	52.0 ± 2.6 a,1
OH90P	32.3 ± 1.3 a,1	36.0 ± 1.1 b,1	37.7 ± 1.2 b,1	37.6 ± 2.8 b,1	37.8 ± 3.6 b,1
OH180P	34.9 ± 2.0 a,2	35.9 ± 3.3 a-b,1	36.0 ± 2.1 a-b,1	38.4 ± 1.7 bc,1-2	39.4 ± 1.7 c,1-2
OE90P	30.9 ± 1.4 a,1	34.9 ± 0.5 b,1	37.2 ± 2.5 b,1	41.2 ± 2.9 c,2-3	41.5 ± 2.7 c,2-3
OE180P	36.5 ± 12 a-b,2	36.2 ± 2.4 a,1	39.1 ± 1.8 b,1	42.0 ± 2.3 c,3	43.8 ± 1.2 c,3

Hand-peeled (H) and electrically peeled (E) white (W) and orange (O) prickly pears packaged in 90PPlus (90P) and 180PPlus (180P) film. Different letters in a row indicate that there were significant differences between storage days ($p < 0.05$), and different numbers in a column indicate that there were significant differences between samples ($p < 0.05$).

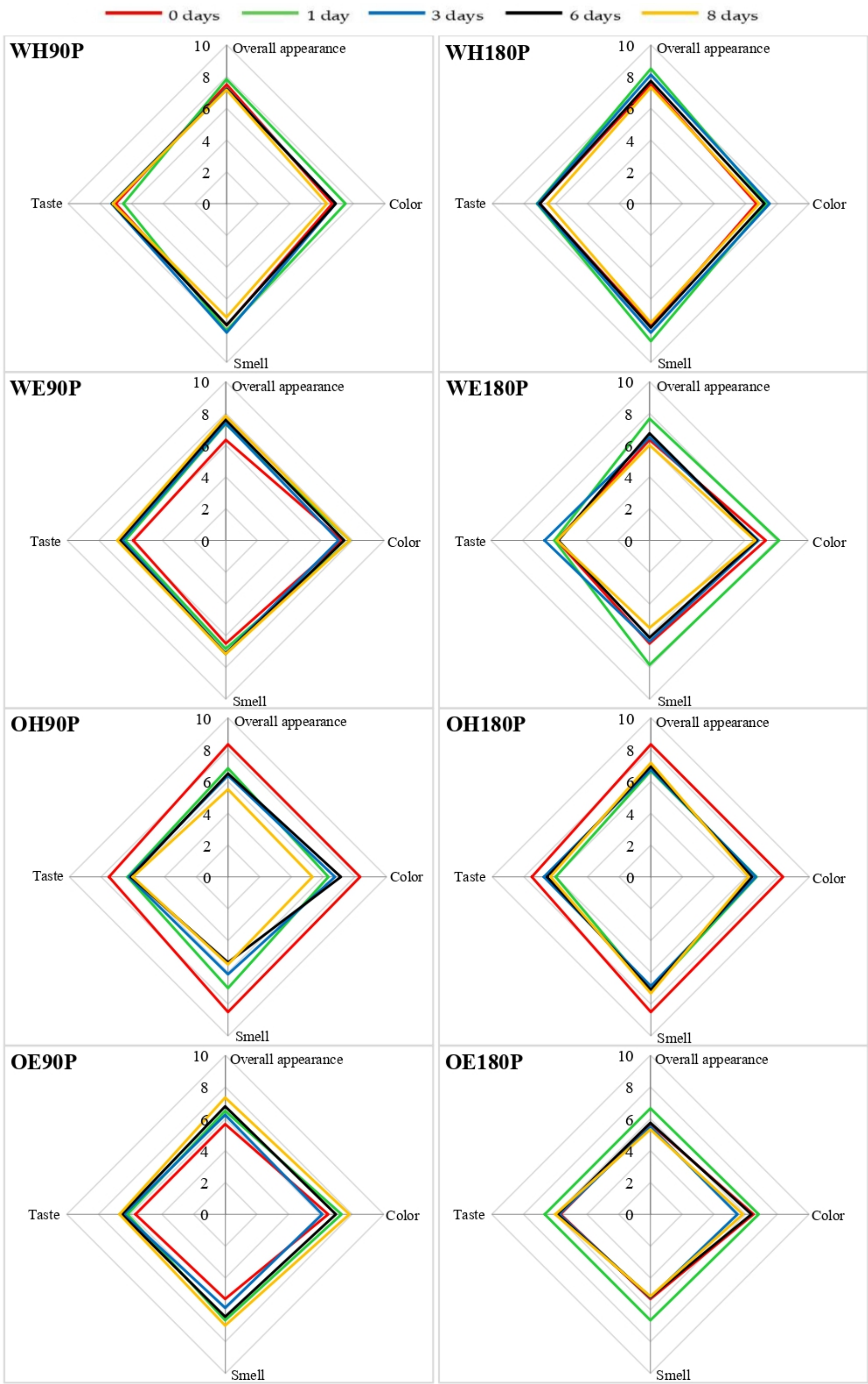
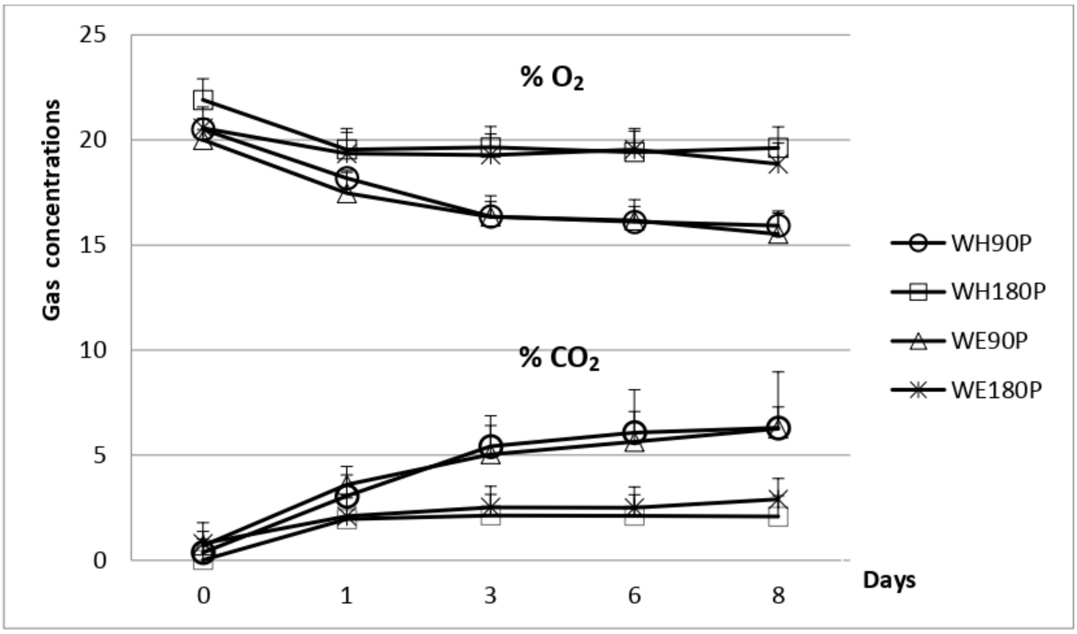
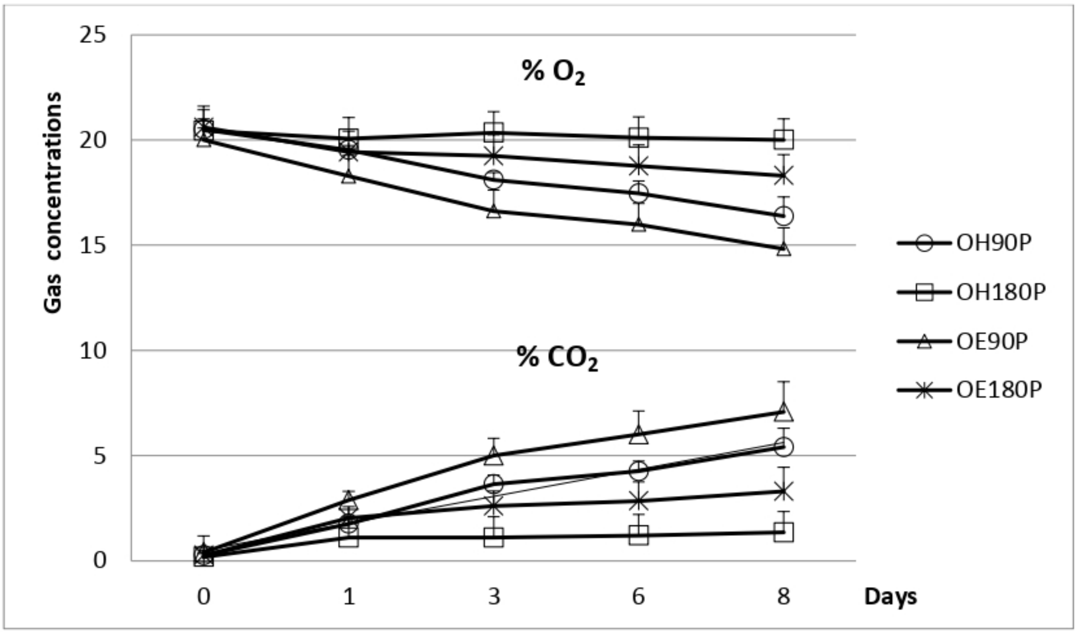


Figure 2. Taster evaluation of the color, smell, taste, and overall appearance of hand-peeled (H) and electrically peeled (E) white (W) and orange (O) prickly pears packaged in 90PPlus (90P) and 180PPlus (180P) film.



(a)



(b)

Figure 3. (**a**) CO_2 and O_2 concentration (%) evolutions inside white prickly pear trays; (**b**) CO_2 and O_2 concentration (%) evolutions inside orange prickly pear trays. Hand-peeled (H) and electrically peeled (E) white (W) and orange (O) prickly pears were packaged in 90PPlus (90P) and 180PPlus (180P) film.

In general, loss of color (ΔE) (Table 3) was only observed in electrically peeled prickly pears packed with 180PPlus film, though this parameter was not affected by storage time in the other types of prickly pears, even showing improvement in the case of WH90P. Allegra et al. [39] also reported losses of color, especially after 7 days of storage, as did Ochoa-Velasco and Guerrero-Beltrán [40]. Film type did not influence color loss, with the exception of the OE packed with 90P film that presented higher losses than those packed in 180PPlus film. The whiteness index (WI) significantly increased with the storage time in all types of studied orange prickly pears, though it did not change over time in the white ones, except in WH180P in which it decreased. Likewise, the WI was much higher in white prickly pears than in the orange ones. The types of peeling and film did not significantly affect this parameter.

3.4.2. Hardness and Texture

The hardness (Table A1, Appendix A) did not significantly change over the 8 days of cold storage in the studied varieties, except when the white ones were electrically peeled and packed in either of the two films. The hardness of the electrically peeled white and orange prickly pears was higher (50.8 and 42.9 °Durofel for white and orange varieties, respectively) than that of the manually peeled pears (32.1 and 31.3 °Durofel for white and orange varieties, respectively) for all storage times and both types of film. Hardness presented significantly different values during the entire shelf life of the white prickly pears, but the hardness values stopped showing differences by day 3 for the orange prickly pears. The influence of the type of film used was negligible, especially in the orange prickly pears; it was only detected that WH180P showed higher ($p < 0.05$) hardness values than WH90P from day 1 to day 6 of packaging. Another interesting parameter was texture, which was evaluated with a Kramer cell that simulated mastication (Table A1, Appendix A). We found that texture significantly increased during the 8 days of storage, except in WH90P, OE180P, and OE90P, for which it decreased ($p < 0.05$). White prickly pears showed higher texture values than the orange ones during shelf life (10.6 and 6.1 N s/g f.w., respectively). In addition, the texture values were significantly higher when the white prickly pears were peeled by hand than with the electric peeler (11.7 and 9.5 N s/g f.w., respectively). In the orange variety, the electrically peeled fruits presented significantly higher values than the manually peeled ones at the beginning of cold storage. The type of film used in packaging did not influence this parameter.

3.4.3. Dry Matter, pH, and Acidity

At the beginning of storage, the dry matter content (data not shown) was higher in the white prickly pears than in the orange ones (19.8% and 17.5%, respectively), and it was higher in those white fruits peeled by hand than with the electric peeler (21.1% and 18.5%, respectively). Thus, WH were the prickly pears with the highest dry matter values (≥20.5%), and the OE showed the lowest values (<16.5%). Likewise, the dry matter contents of both varieties, regardless of the type of film and peeling, remained almost constant throughout cold storage, which was similar to the results reported by Piga et al. [12] for the "Gialla" variety. The hand-peeled prickly pears showed higher pH values and lower acidity values than the electrically peeled pears (data not shown). It was observed that the pH significantly decreased after 8 days of storage in WH180P, OH180P, and OE180P, and the acidity significantly increased in WH180P, OH90P, and OE180P. In the other treatments, both pH and acidity remained constant over time. Accordingly, the lowest pH value was detected in OE180P at 8 days of storage (pH = 5.39), and pH values lower than 6 were also observed in OE90P. The film used in packaging had little impact on the values of these two parameters in the studied varieties. Piga et al. [12] analyzed prickly pears of the "Gialla" variety and reported similar results (decreases in pH during storage) when fruits were manually peeled and stored at 4° C for 9 days. Ochoa-Velasco and Guerrero-Beltrán [40] detected decreases in pH with storage time (16 days at 4° C) in white prickly pears of the *O. albicarpa* species. However, Palma et al. [38] reported that pH and acidity significantly decreased with storage time (at 4 °C/10 days) in the orange "Gialla" variety, though they remained constant in the white "Bianca" variety.

3.4.4. Sugars

In general, the TSS content was higher in the white prickly pears than in the orange ones (Table 4). However, Palma et al. [38] did not observe that the prickly pears of the "Bianca" variety were sweeter than those of the "Gialla" variety. The prickly pears with the highest and lowest TSS were WH and OE, respectively, which coincided with the results already indicated for dry matter content. In all cases, a decrease in TSS was observed with storage time, as was also observed by Palma et al. [38] in the “Gialla” variety but not in the “Bianca” variety. Piga et al. [12] detected that TSS content did not significantly change over storage time in the “Gialla” variety (13.5 TSS). Nevertheless, Ochoa-Velasco and Guerrero-Beltrán [40] reported an increase in TSS (from 13.6 to 17.4 in the white variety and from 13.9 to 18.0 in the red variety). It was observed that this decrease was not significant in OE (from 12.3 to ≈11.0). In WH, the TSS decreased ($p < 0.05$) from an initial value of 17.7 to 13.1 (WH90P) and 13.9 (WH180P). No significant differences were detected in TSS depending on the type of packaging film used with the exception of WE, for which those packed in 180PPlus film showed higher values than those packed in 90PPlus film between 1 and 6 storage days. Fructose (Table 4) was the sugar with the highest concentration in all treatments, with the exception of OE at the beginning and the first day of storage, followed by glucose and lastly sucrose, which presented values lower than 1% except in WE. Fructose content in WE and OE increased with storage time, and glucose content in OE decreased with time.

Table 4. Total soluble solids, fructose, glucose, and sucrose contents in white and orange minimally processed prickly pears peeled by hand or with an electric peeler and packed in two films of different permeability during cold storage at 7 °C.

	Storage Period (Days)				
	0	1	3	6	8
	TSS (°Brix)				
WH90P	17.7 ± 1.9 ^{b,1}	17.1 ± 0.4 ^{b,3}	17.0 ± 0.9 ^{b,3}	15.7 ± 1.2 ^{b,2}	13.1 ± 0.3 ^{a,1}
WH180P	17.7 ± 1.9 ^{b,1}	17.3 ± 0.8 ^{b,3}	15.5± 1.7 $^{a\text{-}b,2\text{-}3}$	16.9 ± 0.6 ^{b,2}	13.9 ± 0.3 ^{a,1}
WE90P	16.0 ± 0.9 ^{c,1}	13.3 ± 0.3 $^{a\text{-}b,1}$	12.3 ± 1.2 ^{a,1}	13.0 ± 0.2 $^{a\text{-}b,1}$	13.9 ± 0.4 ^{b,1}
WE180P	16.0 ± 0.9 ^{b,1}	15.5 ± 1.1 ^{b,2}	14.0 ± 0.0 $^{a,1\text{-}2}$	16.2 ± 0.2 ^{b,2}	14.1 ± 0.6 ^{a,1}
OH90P	15.1 ± 1.1 ^{b,2}	14.3 ± 1.0 ^{b,1}	14.7 ± 1.3 ^{b,1}	12.2 ± 0.2 ^{a,1}	11.9 ± 0.3 ^{a,1}
OH180P	15.1 ± 1.1 ^{b,2}	12.3 ± 1.4 ^{a,1}	12.7 ± 1.1 ^{a,1}	11.9 ± 1.1 ^{a,1}	13.0 ± 0.2 ^{a,1}
OE90P	12.3 ± 1.3 ^{a,1}	11.4 ± 1.1 ^{a,1}	12.7 ± 0.5 ^{a,1}	11.5 ± 0.6 ^{a,1}	11.1 ± 0.7 ^{a,1}
OE180P	12.3 ± 1.3 ^{a,1}	13.2 ± 1.1 ^{a,1}	11.1 ± 0.8 ^{a,1}	11.4 ± 0.9 ^{a,1}	11.3 ± 0.4 ^{a,1}
	Fructose (g/100 g f.w.)				
WH90P	6.56 ± 0.0 ^{b,2}	6.04 ± 0.2 ^{a,3}	6.12 ± 0.2 ^{a,3}	6.43 ± 0.2 ^{b,2}	6.02 ± 0.0 $^{a,1\text{-}2}$
WH180P	6.56 ± 0.0 ^{b,2}	6.44 ± 0.1 ^{b,4}	5.67 ± 0.1 $^{a,1\text{-}2}$	6.57 ± 0.1 ^{b,2}	6.41 ± 0.4 ^{b,2}
WE90P	5.11 ± 0.1 ^{a,1}	5.47 ± 0.2 ^{b,2}	5.53 ± 0.2 ^{b,1}	6.47 ± 0.0 ^{c,2}	5.71 ± 0.0 ^{b,1}
WE180P	5.11 ± 0.1 ^{a,1}	5.18 ± 0.1 ^{a,1}	5.94 ± 0.2 $^{b,2\text{-}3}$	6.00 ± 0.1 ^{b,1}	5.75 ± 0.3 ^{b,1}
OH90P	6.56 ± 0.1 ^{c,2}	5.16 ± 0.25 ^{a,2}	5.81 ± 0.4 $^{b,1\text{-}2}$	6.54 ± 0.1 ^{c,3}	6.21 ± 0.2 $^{b\text{-}c,3}$
OH180P	6.56 ± 0.1 ^{a,2}	5.94 ± 0.3 ^{a,3}	6.08 ± 0.2 ^{a,2}	6.22 ± 0.3 ^{a,2}	6.27 ± 0.1 ^{a,3}
OE90P	4.75 ± 0.2 ^{b,1}	4.29 ± 0.1 ^{a,1}	5.30 ± 0.5 ^{c,1}	5.97 ± 0.1 ^{d,2}	5.15 ± 0.1 $^{b\text{-}c,1}$
OE180P	4.75 ± 0.2 ^{a,1}	4.75 ± 0.2 ^{a,2}	5.36 ± 0.2 ^{b,1}	5.16 ± 0.1 ^{b,1}	5.90 ± 0.2 ^{c,2}
	Glucose (g/100 g f.w.)				
WH90P	4.84 ± 0.1 ^{b,2}	4.23 ± 0.2 ^{a,2}	4.04 ± 0.1 ^{a,2}	4.24 ± 0.1 ^{a,2}	4.15 ± 0.0 $^{a,2\text{-}3}$
WH180P	4.84 ± 0.1 ^{c,2}	4.70 ± 0.0 ^{c,3}	4.11 ± 0.1 ^{a,2}	4.37 ± 0.0 ^{b,3}	4.36 ± 0.2 ^{b,2}
WE90P	3.94 ± 0.2 $^{b\text{-}c,1}$	3.96 ± 0.2 ^{bc,1}	3.60 ± 0.1 ^{a,1}	4.15 ± 0.0 ^{c,2}	3.82 ± 0.0 $^{a\text{-}b,1}$
WE180P	3.94 ± 0.2 ^{a,1}	3.75 ± 0.1 ^{a,1}	3.99 ± 0.1 ^{a,2}	3.79 ± 0.1 ^{a,1}	4.08 ± 0.2 $^{a,1\text{-}2}$
OH90P	4.85 ± 0.0 ^{c,2}	3.95 ± 0.1 ^{a,2}	3.72 ± 0.2 ^{a,1}	4.87 ± 0.2 ^{c,3}	4.38 ± 0.2 ^{b,2}
OH180P	4.85 ± 0.0 ^{c,2}	4.22 ± 0.2 ^{b,2}	3.87 ± 0.2 ^{a,1}	4.20 ± 0.2 ^{b,2}	4.59 ± 0.1 ^{c,2}
OE90P	4.02 ± 0.2 ^{b,1}	3.46 ± 0.0 ^{a,1}	3.65 ± 0.3 ^{a,1}	4.23 ± 0.0 ^{b,2}	3.65 ± 0.1 ^{a,1}
OE180P	4.02 ± 0.2 ^{b,1}	3.62 ± 0.1 ^{a,1}	3.63 ± 0.1 ^{a,1}	3.56 ± 0.0 ^{a,1}	3.68 ± 0.1 ^{a,1}
	Sucrose (g/100 g f.w.)				
WH90P	0.72 ± 0.0 ^{d,1}	0.67 ± 0.0 ^{c,1}	0.58 ± 0.0 ^{b,1}	0.67 ± 0.0 ^{c,1}	0.46 ± 0.0 ^{a,1}
WH180P	0.72 ± 0.0 ^{c,1}	0.84 ± 0.0 ^{d,2}	0.60 ± 0.0 ^{b,1}	0.63 ± 0.0 ^{b,1}	0.53 ± 0.0 ^{a,2}
WE90P	1.20 ± 0.1 ^{b,2}	1.58 ± 0.1 ^{c,4}	1.25 ± 0.1 ^{b,3}	0.69 ± 0.0 ^{a,1}	0.65 ± 0.0 ^{a,3}
WE180P	1.20 ± 0.1 ^{c,2}	0.93 ± 0.0 ^{b,3}	0.67 ± 0.0 ^{a,2}	0.73 ± 0.1 ^{a,1}	0.96 ± 0.0 ^{b,4}
OH90P	0.52 ± 0.0 ^{d,2}	0.33 ± 0.0 $^{c,2\text{-}3}$	0.33 ± 0.0 ^{c,4}	0.23 ± 0.0 ^{a,1}	0.28 ± 0.0 ^{b,2}
OH180P	0.52 ± 0.0 ^{c,2}	0.35 ± 0.0 ^{b,3}	0.29 ± 0.0 ^{a,2}	0.29 ± 0.0 ^{a,2}	0.26 ± 0.0 ^{a,2}
OE90P	0.36 ± 0.0 ^{c,1}	0.31 ± 0.0 $^{b,1\text{-}2}$	0.22 ± 0.0 ^{a,1}	0.23 ± 0.0 ^{a,1}	0.21 ± 0.0 ^{a,1}
OE180P	0.36 ± 0.0 ^{c,1}	0.30 ± 0.0 ^{b,1}	0.30 ± 0.0 ^{b,3}	0.25 ± 0.0 ^{a,1}	0.35 ± 0.0 ^{c,3}

Hand-peeled (H) and electrically peeled (E) white (W) and orange (O) prickly pears packaged in 90PPlus (90P) and 180PPlus (180P) film. Different letters in a row indicate that there were significant differences between storage days ($p < 0.05$), and different numbers in a column indicate that there were significant differences between samples ($p < 0.05$).

3.4.5. Bioactive Compound and Antioxidant Capacity Analyses

The ascorbic acid content considerably varied depending on the variety, storage time, and type of peeling (Table 5), but the type of film showed little influence. A decrease in ascorbic acid during storage was observed, and it was more pronounced in the electrically peeled pears. Palma et al. [38] reported a decrease in ascorbic acid content during the storage of the "Bianca" and "Gialla" varieties. In contrast, Piga et al. [12] did not describe any significant differences in the content of this vitamin during the storage of the minimally processed "Gialla" variety. However, it should be noted that after 8 days of storage at 7 °C in this study, the ascorbic acid content ranged between 15 and 21 mg/100 g of fresh weight, with losses relative to the initial time ranging between 8% and 38%. Significant differences were also detected between the white prickly pear treatments for each day of storage, and we obtained different results for the orange variety. WE showed higher values ($p < 0.05$) of ascorbic acid for all storage days than WH, but those differences in the orange ones were not significant ($p > 0.05$) (except on day 3, in which OH showed higher values than OE).

Table 5. Ascorbic acid, total phenolics, and antioxidant capacity (DPPH) in white and orange minimally processed prickly pears peeled by hand or with an electric peeler and packed in two films of different permeability during cold storage at 7 °C.

	Storage Period (Days)				
	0	1	3	6	8
			Ascorbic acid (mg/100 g f.w.)		
WH90P	16.4 ± 0.5 $^{a-b,1}$	17.8 ± 1.3 ^{b,1}	15.1 ± 0.5 ^{a,1}	17.6 ± 0.1 ^{b,1}	15.1 ± 1.6 ^{a,1}
WH180P	16.4 ± 0.5 ^{b,1}	18.5 ± 0.7 ^{c,1}	15.5 ± 0.1 $^{a-b,1}$	16.8 ± 1.0 ^{b,1}	14.9 ± 1.0 ^{a,1}
WE90P	24.9 ± 0.3 ^{b,2}	27.3 ± 1.3 ^{b,2}	21.4 ± 3.3 ^{a,2}	21.5 ± 0.4 ^{a,2}	18.4 ± 0.7 ^{a,2}
WE180P	24.9 ± 0.3 ^{b,2}	25.2 ± 2.4 ^{b,2}	21.9 ± 2.7 $^{a-b,2}$	24.4 ± 0.9 ^{b,2}	21.1 ± 0.7 ^{a,3}
OH90P	25.2 ± 0.4 ^{e,1}	24.2 ± 0.8 ^{d,1}	20.9 ± 0.2 ^{c,3}	18.2 ± 0.4 ^{a,1}	19.1 ± 0.4 ^{b,1}
OH180P	25.2 ± 0.4 ^{b,1}	24.6 ± 0.4 ^{b,1}	19.1 ± 1.2 ^{a,2}	18.6 ± 0.7 ^{a,1}	18.4 ± 0.8 ^{a,1}
OE90P	28.0 ± 2.1 ^{c,1}	24.8 ± 1.0 ^{b,1}	17.9 ± 0.9 $^{a,1-2}$	17.1 ± 2.0 ^{a,1}	17.4 ± 1.1 ^{a,1}
OE180P	28.0 ± 2.1 ^{c,1}	24.3 ± 2.2 ^{b,1}	17.0 ± 0.8 ^{a,1}	18.3 ± 0.4 ^{a,1}	19.7 ± 1.7 ^{a,1}
			Total phenolics (mg GAE/100 g f.w.)		
WH90P	66.9 ± 5.7 $^{a-b,1}$	65.4 ± 2.4 ^{a,1}	77.5 ± 4.4 $^{b-c,1}$	85.0 ± 0.6 ^{c,2}	80.9 ± 11 ^{c,1}
WH180P	66.9 ± 5.7 $^{a-b,1}$	61.0 ± 0.6 ^{a,1}	79.5 ± 7.5 ^{c,1}	71.6 ± 5.5 $^{b-c,1}$	78.6 ± 6.0 ^{c,1}
WE90P	60.7 ± 6.3 ^{a,1}	79.9 ± 19 $^{b,1-2}$	120 ± 1.0 ^{d,3}	98.6 ± 4.9 ^{c,3}	122 ± 1.1 ^{d,2}
WE180P	60.7 ± 6.3 ^{a,1}	86.5 ± 7.5 ^{b,2}	98.7 ± 5.4 ^{c,2}	94.9 ± 6.4 $^{b-c,3}$	121 ± 6.1 ^{d,2}
OH90P	59.6 ± 2.4 ^{a,1}	105 ± 13 ^{c,2}	96.6 ± 5.4 $^{b-c,1}$	84.0 ± 9.2 ^{b,1}	91.9 ± 4.6 $^{b-c,1}$
OH180P	59.6 ± 2.4 ^{a,1}	73.0 ± 9.3 ^{b,1}	97.6 ± 3.5 ^{d,1}	91.8 ± 2.2 $^{c-d,1}$	86.3 ± 2.2 ^{c,1}
OE90P	85.7 ± 5.6 ^{a,2}	111 ± 6.9 $^{b-c,2}$	117 ± 20 $^{b-c,1}$	102 ± 2.6 $^{a-b,2}$	127 ± 9.2 ^{c,2}
OE180P	85.7 ± 5.6 ^{a,2}	137 ± 3.4 ^{c,3}	106 ± 14 ^{b,1}	147 ± 0.9 $^{c-d,3}$	152 ± 5.7 ^{d,3}
			Antioxidant capacity (DPPH) (mg TE/100 g f. w.)		
WH90P	2.2 ± 0.1 ^{a,2}	2.1 ± 0.4 ^{a,1}	2.1 ± 0.4 ^{a,1}	1.7 ± 0.3 ^{a,1}	1.6 ± 0.6 ^{a,1}
WH180P	2.2 ± 0.1 ^{b,2}	2.1 ± 0.1 ^{b,1}	1.7 ± 0.2 ^{a,1}	1.5 ± 0.2 ^{a,1}	1.5 ± 0.3 ^{a,1}
WE90P	1.8 ± 0.2 ^{a,1}	2.2 ± 0.4 ^{a,1}	1.8 ± 0.3 ^{a,1}	1.8 ± 0.3 ^{a,1}	1.4 ± 0.3 ^{a,1}
WE180P	1.8 ± 0.2 ^{a,1}	2.0 ± 0.1 ^{a,1}	2.0 ± 0.1 ^{a,1}	1.5 ± 0.4 ^{a,1}	1.7 ± 0.7 ^{a,1}
OH90P	1.9 ± 0.4 ^{a,1}	2.0 ± 0.6 ^{a,1}	1.8 ± 0.5 ^{a,1}	1.8 ± 0.4 ^{a,1}	1.8 ± 0.7 ^{a,1}
OH180P	1.9 ± 0.4 ^{a,1}	2.1 ± 0.7 ^{a,1}	1.8 ± 0.5 ^{a,1}	1.8 ± 0.4 ^{a,1}	1.7 ± 0.3 ^{a,1}
OE90P	1.9 ± 0.2 $^{a-b,1}$	2.4 ± 0.2 ^{c,1}	2.2 ± 0.1 $^{b-c,1}$	1.9 ± 0.3 $^{a-b,1}$	1.6 ± 0.4 ^{a,1}
OE180P	1.9 ± 0.2 $^{a-b,1}$	2.2 ± 0.5 ^{b,1}	2.2 ± 0.2 ^{b,1}	1.8 ± 0.2 $^{a-b,1}$	1.4 ± 0.2 ^{a,1}

Hand-peeled (H) and electrically peeled (E) white (W) and orange (O) prickly pears packaged in 90PPlus (90P) and 180PPlus (180P) film. Different letters in a row indicate that there were significant differences between storage days ($p < 0.05$), and different numbers in a column indicate that there were significant differences between samples ($p < 0.05$).

Total phenolic content increased with storage time (Table 5). Ochoa-Velasco and Guerrero-Beltrán [40] found that the phenolic content in white prickly pears slightly decreased during storage but significantly increased in red prickly pears after 4 days of storage. In contrast, Palma et al. [38] reported decreases in the contents of these compounds over storage time in the "Bianca" and "Gialla" varieties and Piga et al. [12] described a decrease after 3 days of storage at 4 °C in the "Gialla" variety. In our study, the white and orange varieties suffered more noticeable increases from days 3 and 1 of storage, respectively. It was also observed that the peeling method influenced the antioxidant compound contents; the electrically peeled pears showed higher values than the hand-peeled pears. Significant differences were observed in OE depending on the type of film, with the exception of days 0 and 3. In contrast to total phenolic content, as storage time progresses, a decrease in antioxidant capacity (DPPH) was observed for both varieties. These results were similar to those obtained by Palma et al. [38] in the "Bianca" variety but not in the "Gialla" variety, as well as those of Piga et al. [12]. No significant differences were detected in antioxidant capacity (DPPH) depending on the type of film used or the type of peeling performed, except for WH fruits that presented higher values than WE at the moment of processing.

4. Conclusions

In this study, minimally processed white and orange prickly pears maintained suitable microbial and nutritional quality after 8 days of storage at 7 °C. Throughout storage, the counts of microorganisms increased regardless of the variety, peeling method, or micro-perforated film used. However, the counts of aerobic mesophiles bacteria remained below the limits established by the Spanish legislation (<7 log(CFU/g f.w.) until day 8. Similarly, the counts of psychrophiles, molds, and yeasts did not exceed values of 6 log(CFU/g f.w.).

Electrically peeled prickly pears presented interesting characteristics from a technological and nutritional point of view. Moreover, the contents of bioactive compounds such as ascorbic acid and total phenolic compounds were higher in the electrically peeled fruits.

Fresh-cut orange prickly pears were well evaluated independently of the peeling method and the micro-perforated film used from the beginning to the end of the experiment. White prickly pears were initially evaluated less well when peeled with the electric peeler than with the knife because the electrically peeled pears presented part of the thick pericarp characteristic of this variety.

We recommend using the 180PPlus film and adjusting the electric peeling method depending on the thickness of the prickly pear pericarp to prevent consumers from perceiving any unpleasant sensation, as occurred with the white prickly pears used in this study.

Electrically peeled minimally processed prickly pears could be a value-added healthy alternative because of their high nutritional quality, thus facilitating their consumption. The by-products generated in the agro-industries can be used for animal feeding or as sources of antioxidants, fiber, natural colorants, mucilage, etc.

Author Contributions: Conceptualization, M.G.L. and G.L.D.-D.; methodology, M.G.L., G.L.D.-D., E.M.R.-R. and E.D.; software, E.M.R.-R. and G.L.D.-D.; validation, E.M.R.-R., G.L.D.-D. and M.G.L.; formal analysis, G.L.D.-D. and E.M.R.-R.; investigation, G.L.D.-D., M.G.L., E.M.R.-R. and E.D.; resources, M.G.L.; data curation, G.L.D.-D. and E.M.R.-R.; writing—original draft preparation, G.L.D.-D.; writing—review and editing, M.G.L., E.M.R.-R. and E.D.; visualization, G.L.D.-D., M.G.L., E.M.R.-R. and E.D.; supervision, M.G.L. and E.M.R.-R.; project administration, M.G.L.; funding acquisition, M.G.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by "Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA)", grant number RTA 2015-00044-C02 "Estudio integral de aprovechamiento de Opuntia (Tuna o Higo Chumbo) para la obtención de derivados e ingredientes funcionales mediante la aplicación de tecnologías innovadoras".

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the sensorial evaluation.

Data Availability Statement: Data will be made available on reasonable request.

Acknowledgments: The authors would like to acknowledge the support and collaboration given by the orchard farmers.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Color, hardness, and texture of manually or electrically peeled white and orange minimally processed prickly pears packed in two films of different permeability during cold storage at 7 °C.

	Storage Period (Days)				
	0	1	3	6	8
	a*				
WH90P	$-4.50 \pm 1.98^{a,2}$	$-4.10 \pm 1.21^{a,2}$	$-3.63 \pm 0.74^{a,2}$	$-3.78 \pm 1.00^{a,2}$	$-3.62 \pm 1.36^{a,2}$
WH180P	$-3.89 \pm 0.92^{a,2}$	$-3.05 \pm 0.29^{a,3}$	$-3.16 \pm 0.76^{a,2}$	$-3.17 \pm 0.39^{a,2}$	$-2.95 \pm 0.35^{a,2}$
WE90P	$-8.08 \pm 1.01^{a,1}$	$-6.71 \pm 0.74^{a,1}$	$-6.68 \pm 0.52^{a,1}$	$-6.71 \pm 1.23^{a,1}$	$-6.42 \pm 1.00^{a,1}$
WE180P	$-7.16 \pm 0.37^{a,1}$	$-7.09 \pm 0.42^{a,1}$	$-7.10 \pm 0.72^{a,1}$	$-6.89 \pm 0.56^{a,1}$	$-6.36 \pm 1.39^{a,1}$
OH90P	$15.1 \pm 3.58^{a,2}$	$13.8 \pm 1.41^{a,1}$	$12.8 \pm 3.08^{a,1}$	$12.1 \pm 2.54^{a,1}$	$12.0 \pm 2.63^{a,1}$
OH180P	$15.9 \pm 3.46^{a,2}$	$15.4 \pm 1.65^{a,1}$	$14.6 \pm 2.64^{a,1}$	$13.2 \pm 3.39^{a,1}$	$12.0 \pm 2.75^{a,1}$
OE90P	$20.8 \pm 2.00^{b,3}$	$12.4 \pm 0.76^{a,1}$	$11.6 \pm 2.51^{a,1}$	$12.6 \pm 1.80^{a,1}$	$11.9 \pm 2.73^{a,1}$
OE180P	$8.92 \pm 0.47^{a,1}$	$12.9 \pm 2.39^{a,1}$	$11.0 \pm 3.87^{a,1}$	$9.92 \pm 4.48^{a,1}$	$9.21 \pm 3.29^{a,1}$
	b*				
WH90P	$17.1 \pm 3.22^{a,1}$	$14.5 \pm 3.17^{a,1}$	$13.2 \pm 3.51^{a,1}$	$17.8 \pm 3.93^{a,1}$	$17.7 \pm 3.74^{a,1}$
WH180P	$15.2 \pm 3.05^{b,1}$	$12.1 \pm 1.58^{a,1}$	$13.1 \pm 2.25^{a\text{-}b,1}$	$15.6 \pm 2.20^{b,1}$	$15.8 \pm 1.15^{b,1}$
WE90P	$25.4 \pm 2.95^{b\text{-}c,2}$	$21.1 \pm 3.13^{a,2}$	$22.2 \pm 1.88^{a\text{-}b,2}$	$24.8 \pm 3.56^{a\text{-}c,2}$	$26.3 \pm 2.02^{c,2}$
WE180P	$21.7 \pm 2.17^{a,2}$	$22.4 \pm 2.88^{a,2}$	$23.2 \pm 2.79^{a,2}$	$24.8 \pm 2.76^{a\text{-}b,2}$	$27.9 \pm 3.80^{b,2}$
OH90P	$23.2 \pm 4.38^{a,1}$	$15.5 \pm 6.00^{a,1}$	$15.8 \pm 3.91^{a,1}$	$15.6 \pm 5.04^{a,1}$	$16.3 \pm 4.40^{a,1}$
OH180P	$21.1 \pm 5.02^{a,1}$	$20.7 \pm 1.80^{a,1}$	$19.7 \pm 2.29^{a,1}$	$19.6 \pm 3.88^{a,1}$	$18.5 \pm 2.50^{a,1\text{-}2}$
OE90P	$29.6 \pm 3.43^{b,2}$	$16.8 \pm 3.95^{a,1}$	$17.6 \pm 4.99^{a,1}$	$20.6 \pm 3.49^{a,1}$	$18.6 \pm 3.16^{a,1\text{-}2}$
OE180P	$21.6 \pm 5.39^{a,1}$	$22.4 \pm 5.33^{a,1}$	$21.1 \pm 5.23^{a,1}$	$22.5 \pm 2.68^{a,1}$	$22.8 \pm 2.80^{a,2}$
	Hardness (°Durofel)				
WH90P	$31.0 \pm 2.0^{a,1}$	$28.0 \pm 1.7^{a,1}$	$28.0 \pm 3.0^{a,1}$	$24.7 \pm 3.2^{a,1}$	$27.5 \pm 1.5^{a,1}$
WH180P	$31.0 \pm 2.0^{a,1}$	$38.5 \pm 0.5^{a,2}$	$40.0 \pm 1.0^{a,2}$	$41.0 \pm 4.6^{a,2}$	$31.5 \pm 9.5^{a,1}$
WE90P	$57.0 \pm 1.0^{b,2}$	$51.3 \pm 5.5^{a,3}$	$45.5 \pm 5.5^{a,2\text{-}3}$	$53.5 \pm 0.5^{b,3}$	$55.0 \pm 4.6^{b,2}$
WE180P	$57.0 \pm 1.0^{c,2}$	$41.0 \pm 1.0^{a,2}$	$49.5 \pm 2.5^{b,3}$	$50.3 \pm 3.1^{b,3}$	$48.3 \pm 6.0^{b,2}$
OH90P	$38.0 \pm 2.0^{a,1}$	$32.0 \pm 5.2^{a,1}$	$29.8 \pm 3.0^{a,1}$	$30.3 \pm 7.1^{a,1}$	$27.0 \pm 5.3^{a,1}$
OH180P	$38.0 \pm 2.0^{a,1}$	$28.3 \pm 4.0^{a,1}$	$29.5 \pm 3.0^{a,1}$	$29.5 \pm 3.0^{a,1}$	$30.7 \pm 6.4^{a,1}$
OE90P	$48.7 \pm 4.2^{a,2}$	$41.7 \pm 3.8^{a,2}$	$43.3 \pm 8.0^{a,2}$	$39.3 \pm 9.6^{a,1}$	$34.6 \pm 10.1^{a,1}$
OE180P	$48.7 \pm 4.2^{a,2}$	$42.1 \pm 1.0^{a,2}$	$42.5 \pm 0.5^{a,2}$	$44.4 \pm 9.0^{a,1}$	$43.8 \pm 2.7^{a,1}$
	Texture (N s/g fresh weight)				
WH90P	$10.4 \pm 1.5^{a,2}$	$12.1 \pm 2.3^{a,1}$	$11.4 \pm 2.5^{a,2\text{-}3}$	$10.3 \pm 2.2^{a,1}$	$10.0 \pm 0.4^{a,1}$
WH180P	$10.4 \pm 1.5^{a,2}$	$11.1 \pm 1.8^{a\text{-}b,1}$	$13.5 \pm 0.6^{b,3}$	$13.7 \pm 2.0^{b,1}$	$13.6 \pm 0.4^{b,3}$
WE90P	$7.5 \pm 0.8^{a,1}$	$8.3 \pm 0.4^{a\text{-}b,1}$	$8.5 \pm 0.3^{b,1}$	$9.6 \pm 0.7^{c,1}$	$11.6 \pm 0.3^{d,2}$
WE180P	$7.5 \pm 0.8^{a,1}$	$10.1 \pm 2.0^{b,1}$	$10.8 \pm 0.7^{b,1\text{-}2}$	$11.8 \pm 0.8^{b,1}$	$9.8 \pm 0.5^{b,1}$
OH90P	$3.6 \pm 0.6^{a,1}$	$3.6 \pm 0.9^{a,1}$	$5.7 \pm 0.6^{b,1}$	$5.1 \pm 1.0^{a\text{-}b,1}$	$5.6 \pm 1.3^{b,1}$
OH180P	$3.6 \pm 0.6^{a,1}$	$5.2 \pm 2.0^{a\text{-}b,1\text{-}2}$	$6.5 \pm 0.3^{b,1}$	$5.7 \pm 0.2^{b,1}$	$6.6 \pm 0.2^{b,1}$
OE90P	$7.7 \pm 0.5^{b,2}$	$7.3 \pm 0.3^{b,2}$	$6.2 \pm 0.8^{a,1}$	$6.1 \pm 0.4^{a,1}$	$5.6 \pm 0.2^{a,1}$
OE180P	$7.7 \pm 0.5^{a,2}$	$5.7 \pm 0.3^{a,12}$	$8.9 \pm 2.3^{a,1}$	$8.3 \pm 0.7^{a,2}$	$7.6 \pm 1.2^{a,1}$

Hand-peeled (H) and electrically peeled (E) white (W) and orange (O) prickly pears packaged in 90PPlus (90P) and 180PPlus (180P) film. Different letters in a row indicate that there were significant differences between storage days ($p < 0.05$), and different numbers in a column indicate that there were significant differences between samples ($p < 0.05$).

References

1. Yahia, E.M. *Fruit and Vegetable Phytochemicals: Chemistry and Human Health*; John Wiley & Sons: Hoboken, NJ, USA, 2017; Volume 2, ISBN 978-1-119-15794-6.
2. Paz, P.L.P.; de Padrón, C.E.H. *Plantas Medicinales o Útiles en la Flora Canaria: Aplicaciones Populares*; Detalles Del Producto: La Laguna, Spain, 1999; ISBN 978-84-87973-12-3.
3. Cano, M.P.; Gómez-Maqueo, A.; García-Cayuela, T.; Welti-Chanes, J. Characterization of Carotenoid Profile of Spanish Sanguinos and Verdal Prickly Pear (*Opuntia ficus-indica*, spp.) Tissues. *Food Chem.* **2017**, *237*, 612–622. [CrossRef] [PubMed]
4. Kossori, R.L.; Villaume, C.; Boustani, E.; Sauvaire, Y.; Méjean, L. Composition of Pulp, Skin and Seeds of Prickly Pears Fruit (*Opuntia ficus-indica*, sp.). *Plant Foods Hum. Nutr.* **1998**, *52*, 263–270. [CrossRef] [PubMed]
5. Hernández-Pérez, T.; Carrillo-López, A.; Guevara-Lara, F.; Cruz-Hernández, A.; Paredes-López, O. Biochemical and Nutritional Characterization of Three Prickly Pear Species with Different Ripening Behavior. *Plant Foods Hum. Nutr.* **2005**, *60*, 195–200. [CrossRef] [PubMed]
6. Silva, M.A.; Albuquerque, T.G.; Pereira, P.; Ramalho, R.; Vicente, F.; Oliveira, M.B.P.P.; Costa, H.S. *Opuntia ficus-indica* (L.) Mill.: A Multi-Benefit Potential to Be Exploited. *Molecules* **2021**, *26*, 951. [CrossRef]
7. Gómez-Maqueo, A.; Steurer, D.; Welti-Chanes, J.; Cano, M.P. Bioaccessibility of Antioxidants in Prickly Pear Fruits Treated with High Hydrostatic Pressure: An Application for Healthier Foods. *Molecules* **2021**, *26*, 5252. [CrossRef]

8. Osuna-Martínez, L.; Reyes Esparza, J.; Rodríguez-Fragoso, L. Cactus (*Opuntia ficus-indica*): A Review on Its Antioxidants Properties and Potential Pharmacological Use in Chronic Diseases. *Nat. Prod. Chem. Res.* **2014**, *2*, 153–160. [CrossRef]
9. Gómez-Maqueo, A.; Antunes-Ricardo, M.; Welti-Chanes, J.; Cano, M.P. Digestive Stability and Bioaccessibility of Antioxidants in Prickly Pear Fruits from the Canary Islands: Healthy Foods and Ingredients. *Antioxidants* **2020**, *9*, 164. [CrossRef]
10. Flores, C.A.; de Luna, J.M.; Ramirez, P.P. *Mercado Mundial Del Nopalito*; Servicios a la Comercialización Agropecuaria (ASERCA)/Universidad Autónoma Chapingo (UACh)/Centro de Investigaciones Económicas, Sociales y Tecnológicas de la Agroindustria y la Agricultura Mundial (CIESTAAM): Chapingo, México, 1995; 177p.
11. Artés, F.; Allende, A. Minimal Fresh Processing of Vegetables, Fruits and Juices. In *Emerging Technologies for Food Processing*; Elsevier: Amsterdam, The Netherlands, 2005; Volume 26, pp. 677–716, ISBN 978-0-12-676757-5.
12. Piga, A.; Caro, A.D.; Pinna, I.; Agabbio, M. Changes in Ascorbic Acid, Polyphenol Content and Antioxidant Activity in Minimally Processed Cactus Pear Fruits. *LWT Food Sci. Technol.* **2003**, *2*, 257–262. [CrossRef]
13. Abadias, M.; Usall, J.; Anguera, M.; Solsona, C.; Viñas, I. Microbiological Quality of Fresh, Minimally-Processed Fruit and Vegetables, and Sprouts from Retail Establishments. *Int. J. Food Microbiol.* **2008**, *123*, 121–129. [CrossRef]
14. Kahramanoglu, I.; Usanmaz, S.; Okatan, V.; Wan, C. Preserving Postharvest Storage Quality of Fresh-Cut Cactus Pears by Using Different Bio-Materials. *CABI Agric. Biosci.* **2020**, *1*, 7. [CrossRef]
15. Troyo, R.; Acedo, A.J. Effects of Calcium Ascorbate and Calcium Lactate on Quality of Fresh-Cut Pineapple (Ananas Comosus). *Int. J. Agric. For. Life Sci.* **2019**, *3*, 143–150.
16. Padrón Mederos, M.A.; Rodríguez-Galdón, B.; Díaz-Romero, C.; Lobo, G.; Rodríguez-Rodríguez, E. Quality Evaluation of Minimally Fresh-Cut Processed Pineapples. *LWT* **2020**, *129*, 109607. [CrossRef]
17. Agar, I.; Massantini, R.; Hess-Pierce, B.; Kader, A. Postharvest CO2 and Ethylene Production and Quality Maintenance of Fresh-Cut Kiwi fruit Slices. *J. Food Sci.* **2006**, *64*, 433–440. [CrossRef]
18. Silva, F.A.; Finkler, L.; Finkler, C.L.L. Effect of Edible Coatings Based on Alginate/Pectin on Quality Preservation of Minimally Processed "Espada" Mangoes. *J. Food Sci. Technol.* **2018**, *55*, 5055–5063. [CrossRef] [PubMed]
19. Mphahlele, R.R.; Caleb, O.J.; Ngcobo, M.E.K. Effects of Packaging and Duration on Quality of Minimally Processed and Unpitted Litchi Cv. "Mauritius" under Low Storage Temperature. *Heliyon* **2020**, *6*, e03229. [CrossRef] [PubMed]
20. Kohli, D.; Champawat, P.S.; Mudgal, V.D.; Jain, S.K.; Tiwari, B.K. Advances in Peeling Techniques for Fresh Produce. *J. Food Process Eng.* **2021**, *44*, e13826. [CrossRef]
21. Tapia, M.; Gutiérrez-Pacheco, M.M.; Vázquez Armenta, F.J.; González Aguilar, G.A.; Ayala-Zavala, J.F.; Rahman, M.S.; Siddiqui, M.W. Washing, Peeling and Cutting of Fresh-Cut Fruits and Vegetables. In *Minimally Processed Foods*; Springer: Berlin/Heidelberg, Germany, 2015; pp. 57–78, ISBN 978-3-319-10677-9.
22. Emadi, B.; Yarlagadda, P. Peeling Pumpkin Using Rotary Cutter. In *Proceedings, Global Congress on Manufacturing and Management, GCMM 2006*; Ciampi, M., da Rocha Brito, C., Eds.; COPEC—Council of Researches in Education and Sciences: Santos, Brazil, 2006; pp. 114–118, ISBN 978-85-89120-38-8.
23. Shirmohammadi, M.; Yarlagadda, P.; Kosse, V.; Gu, Y.T. Study of Mechanical Deformations on Tough Skinned Vegetables during Mechanical Peeling Process (A Review). *GSTF J. Eng. Technol.* **2012**, *1*, 31–37. [CrossRef]
24. Alexandre, E.M.C.; Coelho, M.C.; Ozcan, K.; Pinto, C.A.; Teixeira, J.A.; Saraiva, J.A.; Pintado, M. Emergent Technologies for the Extraction of Antioxidants from Prickly Pear Peel and Their Antimicrobial Activity. *Foods* **2021**, *10*, 570. [CrossRef]
25. Djeghim, F.; Bourekoua, H.; Różyło, R.; Bieńczak, A.; Tanaś, W.; Zidoune, M.N. Effect of By-Products from Selected Fruits and Vegetables on Gluten-Free Dough Rheology and Bread Properties. *Appl. Sci.* **2021**, *11*, 4605. [CrossRef]
26. Parafati, L.; Restuccia, C.; Palmeri, R.; Fallico, B.; Arena, E. Characterization of Prickly Pear Peel Flour as a Bioactive and Functional Ingredient in Bread Preparation. *Foods* **2020**, *9*, 1189. [CrossRef]
27. Morshedy, S.A.; Abdal Mohsen, A.E.; Basyony, M.M.; Almeer, R.; Abdel-Daim, M.M.; El-Gindy, Y.M. Effect of Prickly Pear Cactus Peel Supplementation on Milk Production, Nutrient Digestibility and Rumen Fermentation of Sheep and the Maternal Effects on Growth and Physiological Performance of Suckling Offspring. *Animals* **2020**, *10*, 1476. [CrossRef] [PubMed]
28. Ministerio de la Presidencia. *Real Decreto 3484/2000, de 29 de Diciembre, por el que se Establecen las Normas de Higiene para la Elaboración, Distribución y Comercio de Comidas Preparadas*; Ministerio de la Presidencia: Madrid, Spain, 2001; Volume BOE-A-2001-809, pp. 1435–1441.
29. Escalona, V.H.; Aguayo, E.; Artés, F. Quality and Physiological Changes of Fresh-Cut Kohlrabi. *HortScience* **2003**, *38*, 1148–1152. [CrossRef]
30. Karacay, E.; Ayhan, Z. Microbial, Physical, Chemical and Sensory Qualities of Minimally Processed and Modified Atmosphere Packaged "Ready To Eat" Orange Segments. *Int. J. Food Prop.* **2010**, *13*, 960–971. [CrossRef]
31. Panadés, G.; Chiralt, A.; Fito, P.; Rodríguez, I.; Nuñez, M.; Albors, A.; Jiménez, R. Influence of Operating Conditions on Sensory Quality of Minimally Processed Osmotically Dehydrated Guava. *J. Food Qual.* **2003**, *26*, 91–103. [CrossRef]
32. Obenland, D.; Collin, S.; Sievert, J.; Negm, F.; Arpaia, M. Influence of Maturity and Ripening on Aroma Volatiles and Flavor in 'Hass' Avocado. *Postharvest Biol. Technol.* **2012**, *71*, 41–50. [CrossRef]
33. Aguayo, E.; Allende, A.; Artés, F. Keeping Quality and Safety of Minimal Fresh Processed Melon. *Eur. Food Res. Technol.* **2003**, *216*, 494–499. [CrossRef]
34. Horwitz, W.; Latimer, G.W. *Association of Official Analytical Chemists International Official Methods of Analysis of AOAC International*; AOAC International: Gaithersburg, MD, USA, 2006; ISBN 978-0-935584-77-6.

35. Bondet, V.; Brand-Williams, W.; Berset, C. Kinetics and Mechanisms of Antioxidant Activity Using the DPPH.Free Radical Method. *LWT -Food Sci. Technol.* **1997**, *30*, 609–615. [CrossRef]
36. Rodríguez-Galdón, B.; Tascón-Rodríguez, C.; Rodríguez-Rodríguez, E.M.; Díaz-Romero, C. Fructans and Major Compounds in Onion Cultivars (*Allium cepa*). *J. Food Compos. Anal.* **2009**, *22*, 25–32. [CrossRef]
37. Cefola, M.; Renna, M.; Pace, B. Marketability of Ready-to-Eat Cactus Pear as Affected by Temperature and Modified Atmosphere. *J. Food Sci. Technol.* **2014**, *51*, 25–33. [CrossRef]
38. Palma, A.; Continella, A.; Malfa, S.; D'Aquino, S. Changes in Physiological and Some Nutritional, Nutraceuticals, Chemical-Physical, Microbiological and Sensory Quality Minimally Processed Cactus Pears Cvs "Bianca", "Gialla" and "Rossa" Stored under Passive Modified Atmosphere. *J. Sci. Food Agric.* **2017**, *98*, 1839–1849. [CrossRef]
39. Allegra, A.; Sortino, G.; Miciletta, G.; Riotto, M.; Fasciana, T.; Inglese, P. The Influence of Harvest Period and Fruit Ripeness at Harvest on Minimally Processed Cactus Pears (*Opuntia ficus-indica L. Mill.*) Stored under Passive Atmosphere. *Postharvest Biol. Technol.* **2015**, *104*, 57–62. [CrossRef]
40. Ochoa Velasco, C.E.; Guerrero-Beltran, J. Postharvest Quality of Peeled Prickly Pear Fruit Treated with Acetic Acid and Chitosan. *Postharvest Biol. Technol.* **2014**, *92*, 139–145. [CrossRef]