Modified Atmospheres and Ascorbic Acid for Minimally Processed Lettuce

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Abstract. **Sales of minimally processed vegetables in the European and American markets has increased significantly in the last few years due to increased usage and availability in restaurants, institutions, and supermarkets. Increased sales are due to the advantages that these products have, since they add fresh and natural foods to consumer diets while shortening food preparation time. It also reduces transportation costs because the waste and non-usable parts are left at the processing house. (Bolin, et al., 1977; McDonald and Risse, 1990; Pretel et al., 1994; Hurst, 1995).**

Our objectives were: 1) to evaluate the influence of minimal processing on the postharvest quality of lettuce and 2) to determine the influence of ascorbic acid as an antioxidant agent and different plastic films with selective permeability to CO_2 and O_2 on chopped lettuce for shelf-life.

Materials and Methods

Coss type lettuce, were selected from a farm located in the central zone of Chile, near Santiago and processed according to the procedure shown in Figure 1.

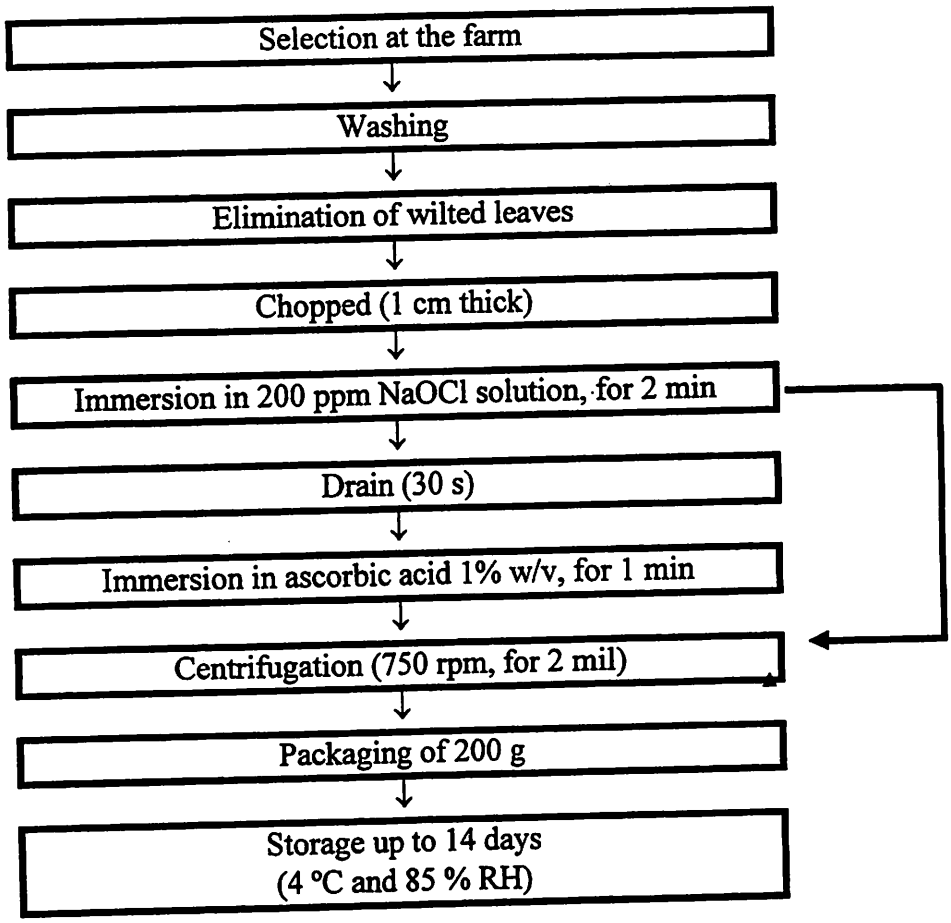

Figure 1. Flow-chart for the minimal processing of lettuce. The arrow in the flow-chart indicates the control, i.e., without ascorbic acid immersion chart

200 g of chopped lettuce was packed in one of three types of 12x17 cm packages provided by Cryovac. O_2 and CO_2 permeabilities for each packaging film are shown in Table 1.

Table 1. Values of CO_2 and O_2 transmission rates (mL x m^{-2} x d^{-1}) of the films used

BAGS	CO_2	O_2
BB4	50-150 (1atm 5°C)	3-6 (1 atm, 5 °C)
PD961	19,000-22,000 (1 atm, 23°C)	6,000-8,000 (1 atm, 23 °C)
BE		4,000 (1 atm, 23 °C)

Analytical measurements. Color valves were measured at the beginning of the experiment, and after 7 and 14 days of storage, using a portable Minolta CR 200b chroma. Gas concentrations within packages were measured after 3, 7, 10 and 14 days of storage, using a gas chromatograph (Hewlett Packard 5890 II).

Sensory evaluation. Product acceptability was determined by 24 judges using a 9 point scale (where 1 = dislike extremely and 9 = like extremely). The results of acceptability were expressed in three categories: acceptance, indifference and rejection.

Statistical analysis. Analysis of variance and Duncan Multiple Comparison Test were performed on five replicates used in each evaluation.

Results and Discussion

Variation in gas concentration. O_2 concentrations within all packages reached equilibrium after 3 days in storage. The PD961 had the highest O_2 levels. The lowest O_2 concentrations, near 1%, were obtained with the BB4 bags (Figure 2). The different decreases in oxygen concentrations in each package can be explained by the different permeability's of the films (Heimdal et al., 1995).

The greatest increase in CO_2 (30%) was observed in the BB4 bags after 3 days in storage. Lettuce in the PD961 bags had CO_2 concentrations of 7.1%, and the BE bags had 12.9 % (Figure 2).

The range of gas concentrations obtained when the PD961 bags were used allowed for acceptance sensory quality for up to 2 weeks. This could be due to the lower levels of CO_2. Ballantyne et al (1988), obtained better sensorial quality with torn lettuce that was packaged in low density films with 1-3% of O_2 and 5-6% of CO_2, thus extending its shelf-life to 14 days at 5°C.

Ascorbic acid effected the package CO_2 and O_2 concentrations when the PD961 bags were used. This may be due to permeability variation of the bag more than to the action of the acid.

The browning process of fruits and vegetables can be evaluated instrumentally, measuring the changes in the values of L*, a* and b* as was shown in apples by Lozano et al (1994) and in lettuce by Castañer et al (1996). Heimdal et al (1995), indicated that enzymatic browning of chopped lettuce can be followed by colorimeter measurements since polyphenol oxidase activity does not correlate with the visible browning.

During storage a decrease in the values of L* was observed, which indicates a darkening of the tissues due to browning. This coincides with results obtained by Castañer et al (1996).

The 'a*' values during storage denotes a loss of the green color and an increase in the purple and red colors (Voss, 1992). Bolin and Huxsoll (1991), showed that during storage green pigmentation decreases in chopped lettuce (Figure 3).

Less variation in color was observed for lettuce in PD961 bags.

Table 1. Variation of color measures of parameters L*, a* and b* using 3 types of bags during 14 days storage period.

Color Values	Days	Bags		
		BB4	PD961	BE
L*	0	59.04 Aa[1/]	54.09 Aa	54.09 Aa
	7	52.26 Aa	53.70 Aa	50.67 ABa
	14	41.17 Bb	50.43 Aa	48.84 Ba
a*	0	-14.31 Ca	-14.31 Ba	-14.31 Ba
	7	-9.95 Ba	-11.05 Aa	-13.31 Bb
	14	-5.90 Aa	-11.49 Ac	-9.42 Ab
b*	0	28.97 Aa	28.97 Aa	28.97 Aa
	7	26.69 Aa	25.56 Aa	27.80 ABa
	14	20.16 Bb	26.922 Aa	25.10 Ba

[1/] Different letters indicate significant differences with error probability at 5% (the capital letters compare vertically and lower case letters compare horizontally).

Chopped lettuce packed in PD961 bags had the highest sensory acceptability after 7 days of storage (Figure 4).

Conclusions

A modified atmosphere with high levels of CO_2 (30%) and low levels of O_2 (1%) is not recommended for chopped lettuce because it severely affects the sensory quality of the product.

The PD961 bags obtained concentrations of 5 to 6 % of CO_2 and 2 to 3 % of O_2 which favored the conservation of the chopped lettuce for up to 7 days.

Lettuce treated with ascorbic acid did not show an improvement in its sensorial quality.

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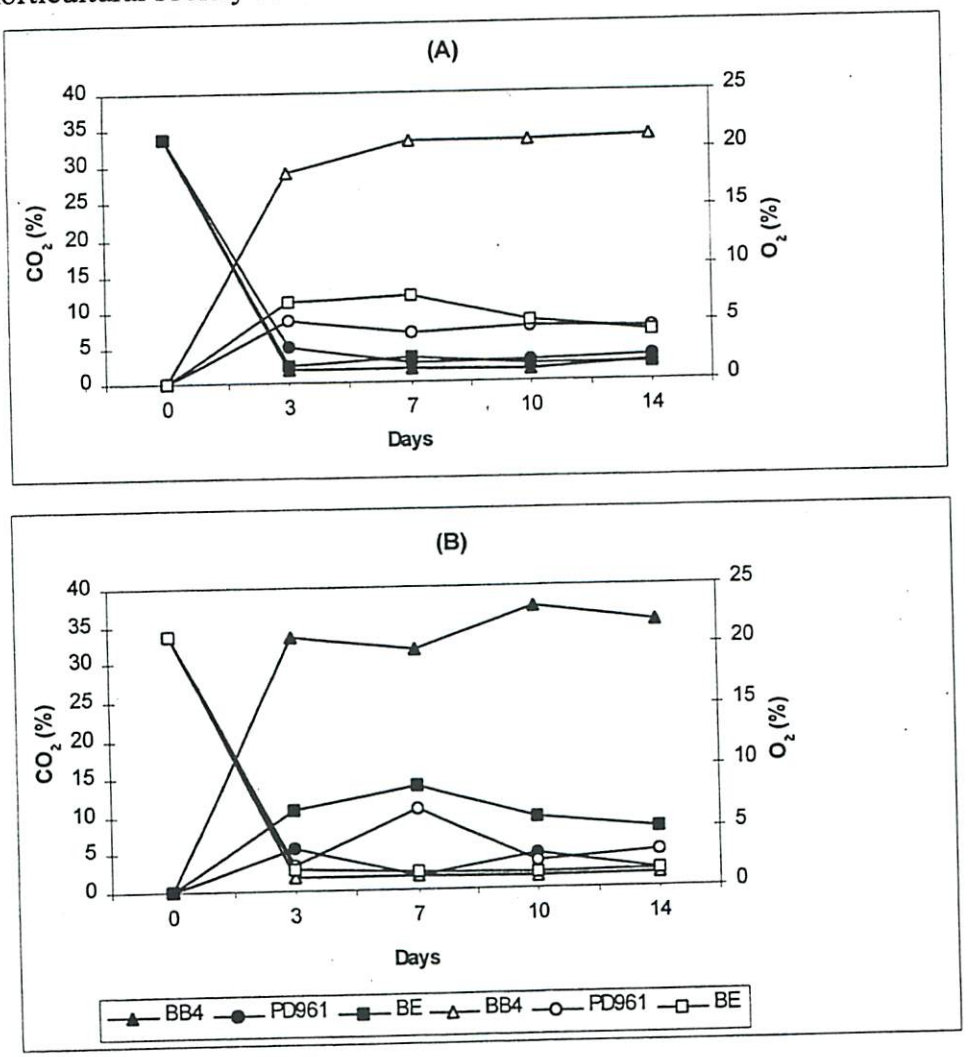

Figure 2. CO_2 and O_2 concentrations inside packages of minimally processed lettuce. A: ascorbic acid 1%. B: ascorbic acid 0%.

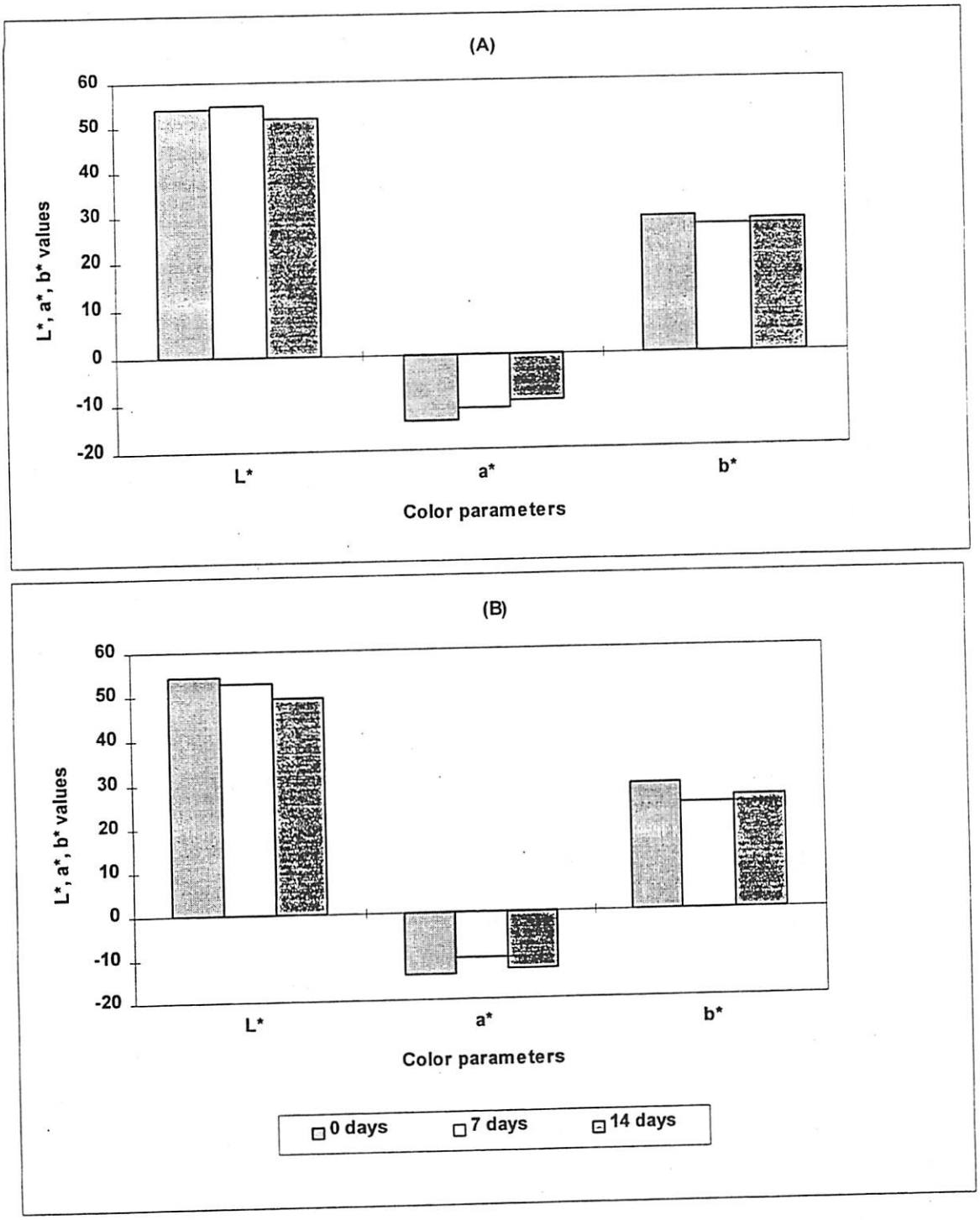

Figure 3. Color changes during storage of lettuce in PD961 bags.
A: ascorbic acid 1%. B: ascorbic acid 0%.

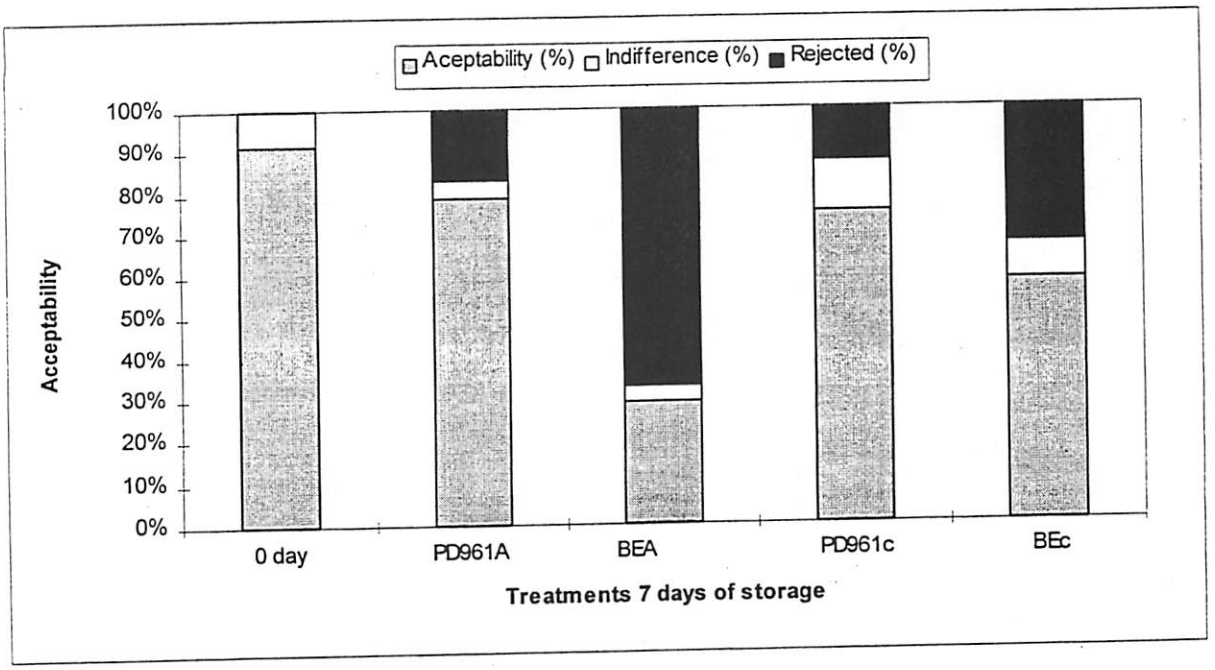

Figure 4. Acceptability of lettuce minimally processed lettuce.