

## Edible coating: Application of *Aloe vera* gel on green beans (*Phaseolus vulgaris* L.)

E. Reiter, A. León, M.E. Galelli, S.S. Miyazaki and A. Chiesa\*

Faculty of Agriculture, University of Buenos Aires, Av. San Martín 4453, C1417DSE, Buenos Aires, Argentina.

\*E-mail: chiesa@agro.uba.ar

### Abstract

Demand for fresh vegetables has led to development of postharvest technologies mainly focused on minimizing the use of chemical additives and look alternatives for food preservation. The use of naturally derived edible coatings emerges as a promising alternative for maintaining quality and safety of horticultural products during storage. The objective of this study was to evaluate the use of *Aloe vera* gel for edible coating in green beans (*Phaseolus vulgaris* L.) to extend postharvest life. Treatments were: immersion 1:1 (50%); 1:3 (25%) with *Aloe* or distilled water (0:1) for 5 minutes at room temperature. Overall visual quality, weight loss, color, firmness, total soluble solids and at the end of storage period microbiological evaluation and electrolyte leakage were measured over 14 days of refrigerated storage at 5 or 10 °C. Results were analyzed by Tukey test and non parametric method was used for visual quality. All samples stored at 5 °C, regardless of *Aloe* gel dose, had higher visual quality, lowest weight loss and better color retention than those stored at 10 °C. Electrolyte leakage was higher in non treated product. Soluble content was higher and weight loss lower in treated samples.

**Key words:** Postharvest, quality, immersion, refrigerated storage

### Introduction

Vegetables for fresh consumption are exposed to a long chain of processes from harvest until they reach consumer during which tissues still alive and with active metabolism, manifested in a series of changes as loss of firmness, change in color, flavor, aroma and catabolic processes (Martinez-Romero *et al.*, 2006). Studies on storage of fresh food focus on maintaining quality and safety, minimizing losses between production and consumption and replacement of chemical additives for the use of natural products due to growing consumers demands (Serrano *et al.*, 2005). An edible coating is a thin layer of digestible material attached to a plant product that reduce variation of flavor, color, nutritional quality and helps to maintain its physical integrity and extend postharvest life of fruits and vegetables. The effectiveness of a treatment depends on the ability to create an effective barrier to gas exchange of the product and is related to the composition of materials used as coatings (Chitravathi *et al.*, 2014).

*Aloe vera* belongs to Liliaceae family consisting of more than 360 genera. Currently It has been included in Aloaceae family (Miranda *et al.*, 2009). It is a perennial succulent plant that grows in hot, dry climates extending through the warm regions of the world. The leaves are fleshy with jagged edged in rosettes. Flowers are tubular and yellow and fruits produce lot of seeds (Khoshgozaran-Abras *et al.*, 2012).

*Aloe* can be acquired as: fluid extract, juice, ointment, concentrated extract, etc. Quality and effectiveness of gel depend on production process, while managing critical safety points (controlled heat treatment, use on antioxidant additives, etc) and critical quality points (raw materials, process optimization, temperature control and storage) (He *et al.*, 2005). Addition of *Aloe* gel as an edible coating is by immersion of food in the extract or spray on food. Because of gelling characteristics of *Aloe* this attaches easily to

the skin of fruits and vegetables (Martinez-Romero *et al.*, 2006).

Green beans having high respiratory rate and heat emission can not be stored longer than four weeks. This is due to the intense metabolic activity within the immature seed pods, advanced ripening, increase the degradation processes, hydrolyzing starch molecules and consume simple sugars in respiration. In order to extend postharvest life of green beans many authors have recommended product storage at 4-10 °C (Sanchez Mata *et al.*, 2003).

The objective of this study was to evaluate the use of *Aloe* gel for edible coating in green beans (*Phaseolus vulgaris* L.) as an alternative, to extend postharvest life.

### Material and methods

Samples of flat green beans of the same cultivar were obtained from Buenos Aires Central Market. *Aloe* gel was provided by Aloeidapergamino (see gel composition). Solution was prepared by diluting gel in water in a ratio 1:3 (25%), 1:1 (50%) or 0:1 (distilled water, control) respectively for each treatment.

Product immersion was performed for 5 minutes at room temperature according to Martinez-Romero *et al.*, (2006). After immersion all material were centrifuged and were placed in plastic trays and about 100±5 g of sample was finally stored in refrigerated chambers at 5 or 10 °C for 14 days. A completely randomized design with three replicates per treatment was used. Destructive samplings were performed twice a week for 14 days.

Overall visual quality was evaluated after removing samples from storage conditions through a subjective evaluation method based on the potential consumer acceptance, with a scale of 9 (excellent) to 1 (extremely poor), being 6 the minimum required for marketing (López Galvez *et al.*, 1996).

Each tray was weighted on a precision balance for obtaining their initial weight (before being placed in chambers) and at the time of sample withdrawal for calculating weight loss (%).

Color of samples was determined using a Minolta Chroma Meter CR 300 colorimeter. L\*, a\* and b\* parameters were taken in middle portion of green beans (León *et al.*, 2007).

Firmness (kg) was measured using a penetrometer (Gullimex, fruit pressure tester FT.327, Italy) in middle part of green beans.

Total soluble solids (%) were determined using a hand refractometer (Atago Optical Works Ltd, Tokyo, Japan).

At the end of storage, electrolyte leakage (%) (Fan and Sokorai, 2005) and total aerobic count (cfu per gram green bean) was recorded (Maturin and Peeler, 2001).

## Results and discussion

**Overall visual quality:** At the end of storage most of the samples lost their minimum visual quality required for marketing. Only green beans stored at 5°C treated with Aloe 1:1 had values above the minimum required for its commercialization, although results analyzed by Bonferroni test indicate that significant differences between treatments were explained by storage temperature and not by the dose of gel in the solution. Overall visual quality was significantly higher in samples stored at 5°C. An edible coating based on *A. vera* gel has also been used to maintain sweet cherry quality and safety during cold storage and uncoated fruits showed increases in respiration rates, rapid weight loss and colour changes leading to a marked decrease in overall visual quality (Martinez-Romero *et al.*, 2006).

**Weight loss:** Treatments recorded weight loss between 25 and 35% of its total weight in two weeks of storage. Significant differences were found between gel treated samples and control. Moreover, significant differences between samples stored at

5°C were observed with those stored at 10°C. Several studies have indicated that Aloe coating reduces weight loss (Benitez *et al.*, 2013; Martínez-Romero *et al.*, 2006). *A. vera* treatment was effective as a physical barrier, reducing weight loss in strawberry fruits (Martinez-Romero *et al.*, 2006).

### Color parameters

**L\* parameter:** L parameter (correlated with luminosity) remained closest to the original value at the end of storage in gel solution treatment with 1:1 stored at 10°C, followed by 1:3 gel treatment stored at 5°C. At the end of storage treatments, samples stored at 10°C had lower L values. Significant differences explained by gel dose were found. In apples slices, Chauhan *et al.* (2011) reported that all formulations with *Aloe* resulted in fewer overall colour changes.

**a\* parameter:** In CIELAB space, a\* values (-) show green color (Li Guo *et al.*, 2007). Treatments without gel, stored at 10 and 5°C exhibited increased variation in the green color. Treatment immersed in 1:3 gel solution and stored at 10°C kept the original green color for longer.

**b\* parameter:** b\* values show yellow color (Li Guo *et al.*, 2007). Significant differences between treatments were observed by an effect of storage temperature than for dose of gel. Treatment stored at 10°C immersed in 1:1 solution gel showed values close to the original (less yellow).

**Firmness:** After three days of storage, significant decreases in firmness were observed in all treatments. After that, loss of firmness between treatments was not significantly different over time and upto the end of experiment. Softening occurs due to the process of deterioration of the cell structure, primarily by the hydrolysis of pectic polymers in the cell wall and middle lamella (Benitez *et al.*, 2013). Kiwifruit slices treated with *Aloe* showed a higher content of pectins and a better general texture in storage than the control samples (Benitez *et al.*, 2013).

Table 1. Overall visual quality of green beans immersed in *Aloe vera* gel (0, 25 and 50 %) during storage in refrigerated chambers at 5 or 10 °C for 14 days

Treatment		Day					
<i>Aloe vera</i> (%)	Temperature (°C)	0	3	7.0	11	14	
0	5	9	7.67	7.0	6.67	5.33	
0	10	9	7.67	6.0	6.33	5	
25	5	9	7.67	8.0	6.33	5.3	
25	10	9	7.67	6.7	6.33	5	
50	5	9	7.33	7.0	6.67	6	
50	10	9	7.33	6.3	6.33	5	

Table 2. Weight loss (%) of green beans immersed in *Aloe vera* gel (0, 25 and 50 %) during storage in refrigerated chambers at 5 or 10 °C for 14 days

Treatment		Day					
<i>Aloe vera</i> (%)	Temperature (°C)	0	3	7	11	14	
0	5	0	10.51	17.21	23.9	31.85	
0	10	0	10.21	17.55	23.38	30.54	
25	5	0	9.42	15.91	23.98	25.87	
25	10	0	9.25	15.19	22.82	33.47	
50	5	0	8.97	14.44	22.03	26.52	
50	10	0	9.89	16.29	22.15	32.85	

Table 3. Color parameters of green beans immersed in *Aloe vera* gel (0, 25 and 50 %) during storage in refrigerated chambers at 5 or 10 °C for 14 days.

Treatment		Day				
<i>Aloe vera</i> (%)	Temperature (°C)	0	3	7	11	14
<b>L*</b>						
0	5	52.39	58.88	60.12	54.48	60.73
0	10	52.39	57.72	58.9	55.82	63.13
25	5	52.39	53.96	57.86	55	60.14
25	10	52.39	56.5	56.21	58.41	62.52
50	5	52.39	58.78	57.13	53.02	60.56
50	10	52.39	52.5	58.09	52.36	58.61
<b>a*</b>						
0	5	13.86	13.46	13.23	10.83	13.5
0	10	13.86	14.64	13.77	12.78	12.88
25	5	13.86	14.25	13.61	12.59	14.09
25	10	13.86	14.32	14.72	11.42	14.37
50	5	13.86	14.38	13.74	11.78	14.06
50	10	13.86	13.69	14.24	12.64	13.65
<b>b*</b>						
0	5	25.83	26.36	26.71	24.33	31.46
0	10	25.83	28.92	28.23	27.84	33.36
25	5	25.83	28.02	27.33	27.86	31.03
25	10	25.83	28.15	27.98	28.29	32.94
50	5	25.83	27.99	27.6	26.2	32.17
50	10	25.83	27.07	29.25	27.41	30.42

**Soluble solids:** Significant decrease in the percentage of soluble solids was observed in all treatments during storage (Table 5). Li Guo *et al.* (2007) stated that the soluble solids descend in the early stages of storage due to their consumption in cellular respiration. At the end of storage untreated samples, stored at 5 °C, showed higher percentage of soluble solids and treated samples 1:1 gel solution had least percentage. However, in kiwifruit slices after 12 days of storage, no significant differences were found in treated fruits (Benitez *et al.*, 2013).

**Electrolyte leakage:** Electrolyte leakage was lower in gel treatment (1:3) stored at both temperature; while it was higher in control. From higher electrolyte leakage we may infer higher membrane damage at cellular level.

**Microbiological evaluation:** This evaluation reflects microbial load of the analyzed product. This indicate hygienic condition of the raw material, the way they were handled. High microbiological

counts are considered ill advised for most foods (Pascual *et al.*, 2000).

High number of colonies forming aerobic mesophilic microorganism (cfu) per gram of green bean were very high at initial sample, which means a high microbial contamination possibly due to the plant material. Values of cfu/g obtained after storage were significantly lower than those obtained at the initial samples, possibly affected by low storage temperature. Differences observed between treatments may be due particular state of each initial contamination.

In kiwifruit slices, an edible coating of *Aloe* gel at four different concentrations (0, 1, 5, 15% v/v), was effective in reducing microbial spoilage (Benitez *et al.*, 2013). Furthermore, microbial populations were significantly reduced in aloe treated sweet cherries (Martínez-Romero *et al.*, 2006).

Table 4. Firmness (kg) of green beans immersed in *Aloe vera* gel (0, 25 and 50 %) during storage in refrigerated chambers at 5 or 10 °C for 14 days

Treatment		Day				
<i>Aloe vera</i> (%)	Temperature (°C)	0	3	7	11	14
0	5	2.2	1.73	2.10	1.80	1.83
0	10	2.2	1.97	2.10	1.97	1.83
25	5	2.2	1.90	1.83	1.80	2.07
25	10	2.2	1.80	1.77	2.00	2.07
50	5	2.2	1.80	1.90	1.93	2.03
50	10	2.2	1.80	1.77	2.03	2.00

Table 5. Soluble solids (%) of green beans immersed in *Aloe vera* gel (0, 25 and 50 %) during storage in refrigerated chambers at 5 or 10 °C for 14 days

Treatment		Day				
<i>Aloe vera</i> (%)	Temperature (°C)	0	3	7	11	14
0	5	17	5.83	6.00	8.83	6.93
0	10	17	6.00	5.33	6.77	5.17
25	5	17	5.50	5.67	6.83	5.73
25	10	17	5.50	4.67	6.57	5.27
50	5	17	5.33	5.17	5.50	4.93
50	10	17	5.67	5.83	5.23	5.67

Table 6. Electrolyte leakage (%) of green beans immersed in *Aloe vera* gel (0, 25 and 50 %) after storage in refrigerated chambers at 5 or 10 °C for 14 days

<i>Aloe vera</i> (%)	Temperature (°C)	EL(%)
0	5	26.76
0	10	24.72
25	5	8.57
25	10	13.99
50	5	13.70
50	10	14.11

Table 7. Microbiological evaluation (cfu per gram green bean) of green beans immersed in *Aloe vera* gel (0, 25 and 50 %) after storage in refrigerated chambers at 5 or 10 °C for 14 days

<i>Aloe vera</i> (%)	Temperature (°C)	Microbiological count (cfu per g)
0	5	692466
0	10	745000
25	5	765333
25	10	677108
50	5	691500
50	10	704933

All samples stored at 5 °C, regardless of Aloe gel dose, had higher visual quality, lowest weight loss and better color retention than those stored at 10 °C. Electrolyte leakage was higher in non treated product. Soluble content was higher and loss weight lower in treated samples.

## References

- Benítez, S., I. Achaerandio, F. Sepulcre and M. Pujola, 2013. *Aloe vera* based coatings improve the quality of minimally processed 'Hayward' kiwifruit. *Postharvest Biology and Technology*, 81: 29-36.
- Chauhan, O.P., P.S. Raju, A. Singh and A.S. Bawa, 2011. Shellac and aloe-gel based surface coatings for maintaining keeping quality of apples slices. *Food Chemistry*, 126: 961-966.
- Chitravathi, K., O.P. Chauhan and P.S. Raju, 2014. Postharvest shelf-life extension of green chillies (*Capsicum annum* L.) using shellac-based edible surface coatings. *Postharvest Biology and Technology*, 92: 146-148.
- Fan, X., K.J.B. Sokorai, 2005. Assessment of radiation sensitivity of fresh-cut vegetables using electrolyte leakage measurement. *Postharvest Biology and Technology*, 36: 191-197.
- He, Q., L. Changhong, E. Kojo and Z. Tian, 2005. Quality and safety assurance in the processing of *Aloe vera* gel juice. *Food Control*, 16: 95-104.
- Khoshgozaran-Abras, S., M. Hossein Azizi, Z. Hamidy and N. Bagheripoor-Fallah, 2012. Mechanical, physicochemical and color properties of chitosan based-films as a function of Aloe gel incorporation. *Carbohydrate Polymers*, 87: 2058-2062.
- León, A.P., S.Z. Viña, D. Frezza, A. Chaves and A. Chiesa, 2007. Estimation of chlorophyll contents by correlations between SPAD 502 meter and chroma meter in butterhead lettuce. *Communications Soil Science Plant Analysis*, 38: 2877-2885.
- Li Guo, Ying Maa, Da-Wen Sun and Peng Wang, 2007. Effects of controlled freezing-point storage at 0 °C on quality of green bean as compared with cold and room-temperature storages. *Journal of Food Engineering*, 86: 25-29.
- López Gálvez, G., M. Saltveit and M. Cantwell, 1996. The visual quality of minimally processed lettuces stored in air or controlled atmosphere with emphasis on romaine and iceberg types. *Postharvest Biology and Technology*, 8: 179-190.
- Martínez-Romero, D., N. Albuquerque, J.M. Valverde, F. Guillén, S. Castillo, D. Valero and M. Serrano, 2006. Postharvest sweet cherry quality and safety maintenance by *Aloe vera* treatment: A new edible coating. *Postharvest Biology Technology*, 39: 93-100.
- Maturin, L.J. and J.T. Peeler, 2001. Aerobic plate count. *Bacteriological Analytical Manual*. In: AOAC, (ed). Chapter 3 [Online]. URL: <http://www.cfsan.fda.gov>.
- Miranda, M., H. Maureira, K. Rodriguez and A. Vega-Galvez, 2009. Influence of temperature on the drying kinetics, physicochemical properties, and antioxidant capacity of Aloe (*Aloe barbadensis* Miller) gel. *Journal of Food Engineering*, 91: 297-304.
- Pascual Anderson, M.R. and V. Calderon y Pascual, 2000. *Microbiología Alimentaria - Metodología analítica para alimentos y bebidas*. 2da edición. Editorial: Díaz de Santos, Madrid, España. 322 pp.
- Sánchez-Mata, M.C., M. Cámara and C. Díez-Marqué, 2003. Extending shelf-life and nutritive value of green beans (*Phaseolus vulgaris* L.), by controlled atmosphere storage: macronutrients. *Food Chemistry*, 80: 309-315.
- Serrano, M., D. Martínez-Romero, F. Guillén, J.M. Valverde, P.J. Zapata, S. Castillo and D. Valero, 2008. The addition of essential oils to MAP as a tool to maintain the overall quality of fruits. *Trends in Food Science & Technology*, 19: 464-471.

Received: December, 2015; Revised: January, 2016; Accepted: February, 2016