

Evaluation of a New Harpin Product on Microbial Quality and Shelf Life of Minimally Processed Lettuce

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Abstract

The effect of pre-harvest application of Extend®, a newly developed second generation harpin product, on shelf life of fresh-cut lettuce was investigated. The lettuces were grown in locations A: Watsonville, CA; B: Cedarville, NJ; and C: Yuma, AZ, and treated five days before harvest at 30, 60 and 90 ppm (2,4 and 6 oz/acre in 50 gal/acre). Lettuce processed and bagged was stored at 34-37°F and evaluated for quality for 20 days. Lettuce from trial A treated with 60-90 ppm harpin consistently had a better overall quality and lower microbial population than the control. Results from trial B showed no differences among treatments. In trial C, microbial population was lower and visual quality higher in lettuce treated at 60 ppm than the control during early stages of storage. Overall results are mixed but it was revealed that a field application of harpin can improve quality of fresh-cut lettuce under conditions that need to be determined.

Introduction

The fresh-cut industry is one of the food segments that have shown highest growth in sales during the last few years. Fresh-cut products are commonly consumed directly from the bags without any further rinse, a convenience that is one of the main reasons for the growing popularity of these products. It is extremely important to have lettuce that contains low microbial population at harvest, before rinsing the lettuce 3-4 times in a sanitizing solution. Although it may be possible that pre-harvest applications of agents affect postharvest microbial population, studies evaluating this fact are lacking.

The harpin protein when applied on crops, activates and enhances a plant's natural defense mechanism against stress-producing conditions such as pests, diseases and extreme environmental conditions. The effect of this protein may also be observed in growth characteristics, yield and quality at harvest. We initially tested Messenger® with little success and then Extend®, which differs from Messenger in that the protein is sourced from different bacteria, with better performance. This prompted us to conduct more trials to confirm those results. Thus, it was the object of this work to evaluate the effect of Extend®, applied few days before harvest to an Iceberg lettuce field on different quality parameters of fresh-cut lettuce.

Materials and Methods

Three trials were conducted. The lettuce for these trials were grown in locations A: Watsonville, CA; B: Cedarville, NJ; and C: Yuma, AZ, and were treated with Extend® five days before harvest at 30, 60 and 90 ppm.

In trial A the study was conducted on Iceberg lettuce cv. Sniper, cultivated commercially. The planting date was July 8, 2004 and harvest was done September 14, 2004. All irrigation was using overhead sprinklers.

Lettuce ‘Desert Queen’ was planted on August 9 on a farm in Cedarville, New Jersey. All irrigation was through a drip system with plastic mulch. Commercial production practices were done during the production season by a commercial grower. Harvest was on October 20, 2004.

In trial C the study was conducted on Iceberg lettuce cv Sahara, cultivated following commercial practices at the Yuma Agricultural Center, Yuma, Arizona. The planting date was September 21, 2004 and harvest was on December 20, 2004. Plants were watered with furrow irrigation during the entire experiment except for the irrigation at germination when overhead sprinklers were used.

Application of Treatments and Evaluations

The treatments were control (no harpin), Extend at 2 oz/acre, Extend at 4 oz/acre, and Extend at 6 oz/acre. The application volume was 50 gallons/acre. The product was sprayed 5 days prior to harvest as recommended by the product’s manufacturer. The temperature during application was 55-60 °F.

The lettuce from the 6 different replicates was transported immediately after harvest and stored inside insulated coolers at 34-37 °F. After three hours, the lettuce was cut in pieces of 1-2 sq. inches (2.5-5.0 sq. cm) and placed in low-density non-perforated polyethylene bags. The temperature during processing was 40-45 ° F. The storage bags were of 1 lb size and contained 450 ± 25 (approximately 1 lb) of processed lettuce.

The parameters of evaluation were (some results are not reported here):

- 1) Overall visual quality was rated using a hedonic 0-9 scale where 9 was excellent, 7 was good, 5 was fair, 3 was poor and 1 was unusable. Salability point in this scale was 6.
- 2) Browning edges (russet spotting or oxidation of tissue) was evaluated using a 0-5-severity scale where 0 was no browning and 5 were severe browning of edges. This parameter was also assessed by separating pieces evidencing oxidated tissue. A composite sample of 200 g was taken from all six bags per replicate and the percentage of pieces with “brown” tissue was calculated by weight differential.
- 3) Color was measured using a C-400 Minolta Chroma meter. An L*, a*, b* scale was used, with L* denoting lightness, where 0 is black and 100 is white, a* green (negative) to red (positive), b* blue (negative) to yellow (positive).
- 4) Decay/breakdown/sliminess was evaluated using a 0-5 severity scale where 0 was no breakdown and 5 were severe breakdown.
- 5) Aroma was evaluated with a 1-5 scale where 1 is no aroma and 5 is full aroma.
- 6) Crispness was estimated using a 1-5 scale where 5 was full crispness and 1 denoted lack of crispness. This was conducted subjectively by breaking mid ribs pieces.
- 7) Off odor was evaluated with a 1-5 scale where 1 was no presence of “strange” aroma, and 5 a very strong rotten type of aroma.
- 8) Analysis of Aerobic Total Count (ATC), using 3M petrifilm® Aerobic count plates. A sample of 7 g of the product was prepared according to the film manufacturer’s recommendations. Dilutions from 10^1 to 10^5 per g of sample were incubated at 70 °F for 48 hours. Six bags from each treatment per replicates were randomly sampled and inoculated.

For subjective parameters the criteria used was based on the opinion of three different judges, and the evaluations were carried by one person. Evaluation of the lettuce was conducted in 5-day intervals for 20 days.

The experimental design for all three trials was a randomized complete block with 6 replicates. This design was used for the placement of treatments in the field. Data were subjected to analysis of variance (ANOVA) at $p \leq 0.05$ to determine statistical significance. Mean comparisons were conducted using Duncan's Multiple Range Test at $p \leq 0.05$ (SAS Institute, Cary, NC).

Results and Discussion

Experimental conditions and subsequent results from the three trials varied. Lettuce from trial A treated at 4-6 oz/ac consistently had a higher overall quality and lower microbial population than the control. In trial B, where wet conditions prevailed immediately after treatment application and during harvest, few differences among treatments were observed. In trial C, lettuce treated at 4 oz/ac had consistently higher quality and lower microbial counts during early stages of storage (data not shown). Although overall results are mixed, data from evaluations conducted 5 days after processing showed differences in overall quality between control and treated lettuce at all three locations. Additionally, at this evaluation time differences in microbial population were observed in trial A and C. In trial B, the control showed the lowest microbial count but no statistical difference was recorded among treatments (Table 1).

The L^* results evidenced some differences between treated lettuce and control. In trial A the control was consistently yielding lower L^* units than the treatment at 4 and 6 oz/ac. This indicates that browning of edges was more pronounced in the control. In trial B, Extend at 4 oz/ac was different from the control in the last evaluation. In trial C, again the lettuce treated at 4 oz/ac was different from the control in several evaluations.

It seems that excess moisture during the application of treatments alter the efficiency of Extend. This was the case in trial B and to a certain degree in trial C, which may explain the lower benefits obtained with Extend in these two trials compared to trial A in California. In trial B, although the product was in contact with the lettuce for at least 60 minutes, it is possible that rainfall, which occurred within three hours from the application, had a negative impact on the treatment.

This study revealed that a field application of harpin can improve quality of fresh-cut lettuce under conditions to be elucidated. Our results encourage further studies to determine the influence of environmental conditions on the plant's response to harpin and reveal that agents that elicit hypersensitive response may be used to improve quality of fresh-cut products.

Acknowledgments

We thank Ramiro Galvez for his assistance in the Watsonville and Yuma trials.

Table 1: Overall visual quality and total aerobic bacteria of fresh-cut lettuce previously applied with Extend®, 5-6 days after processing.

<i>Locations</i> →	Overall Visual Quality (9-1 scale)			Microbial Population (Log ₁₀ CFU/g)		
	A	B	C	A	B <i>ns</i>	C
Control	7.8 b	5.83 b	7.61 b	5.98 a	6.86	6.81 a
Extend 2 oz/ac	7.9 b	5.89 b	7.86 b	5.35 ab	6.36	6.64 ab
Extend 4 oz/ac	8.4 a	6.39 a	8.28 a	5.15 bc	6.26	6.57 b
Extend 6 oz/ac	8.5 a	6.28 a	8.33 a	5.11 c	6.18	6.78 ab

ns indicates no significant differences among values in the same column; *Values followed by different letters in the same column are significantly different (p<0.05).

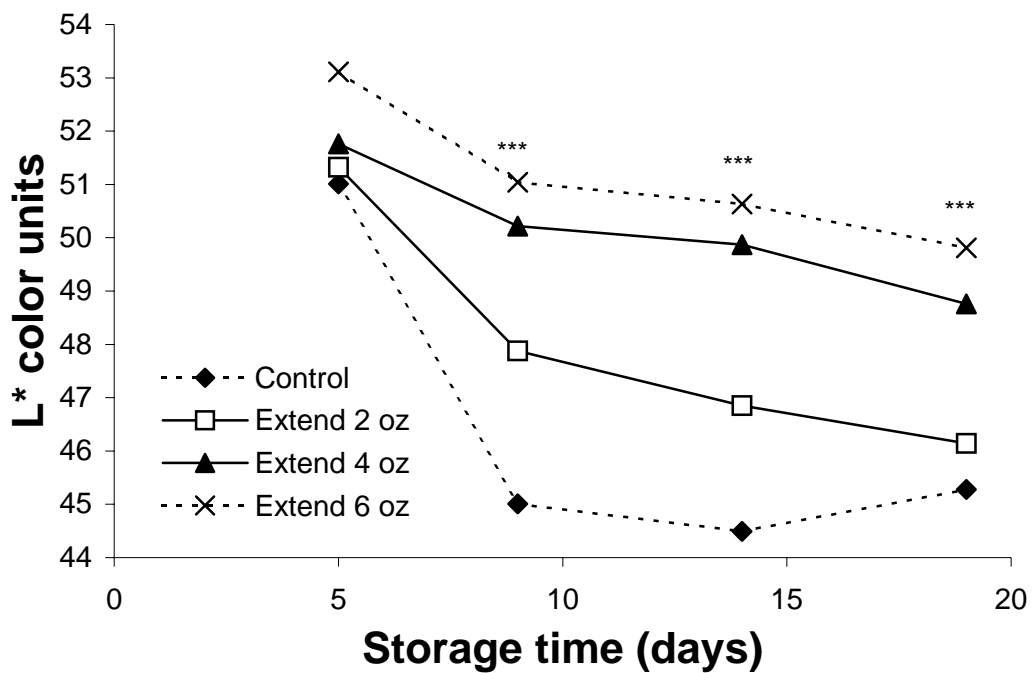


Figure 1. Effect of a single pre-harvest application of Extend® to lettuce grown in Watsonville, California on L* color units of fresh-cut lettuce. Rates of the product are per acre. Higher numbers indicate lighter color. Lower numbers indicate darker color, commonly associated with browning of edges. *** Indicate difference among treatments ($p < 0.05$).

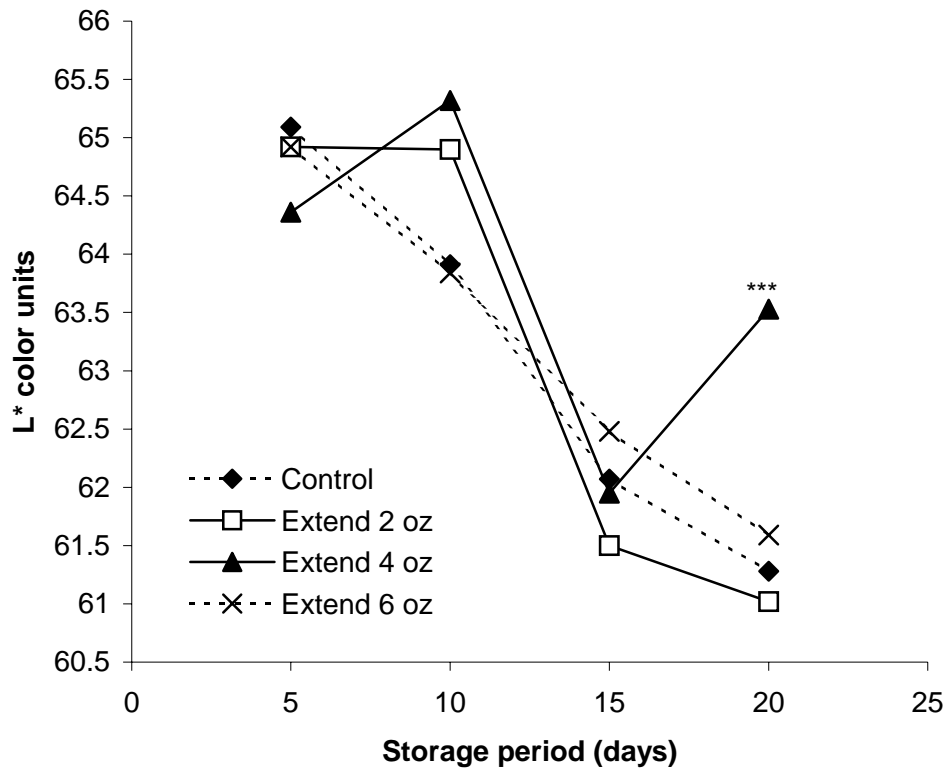


Figure 2. Effect of a single pre-harvest application of Extend® to lettuce grown in Cedarville, New Jersey on L* color units of fresh-cut lettuce. Rates of product are per acre. Higher numbers indicate lighter color. Lower numbers indicate darker color, commonly associated with browning of edges. *** Indicate difference among treatments ($p < 0.05$).

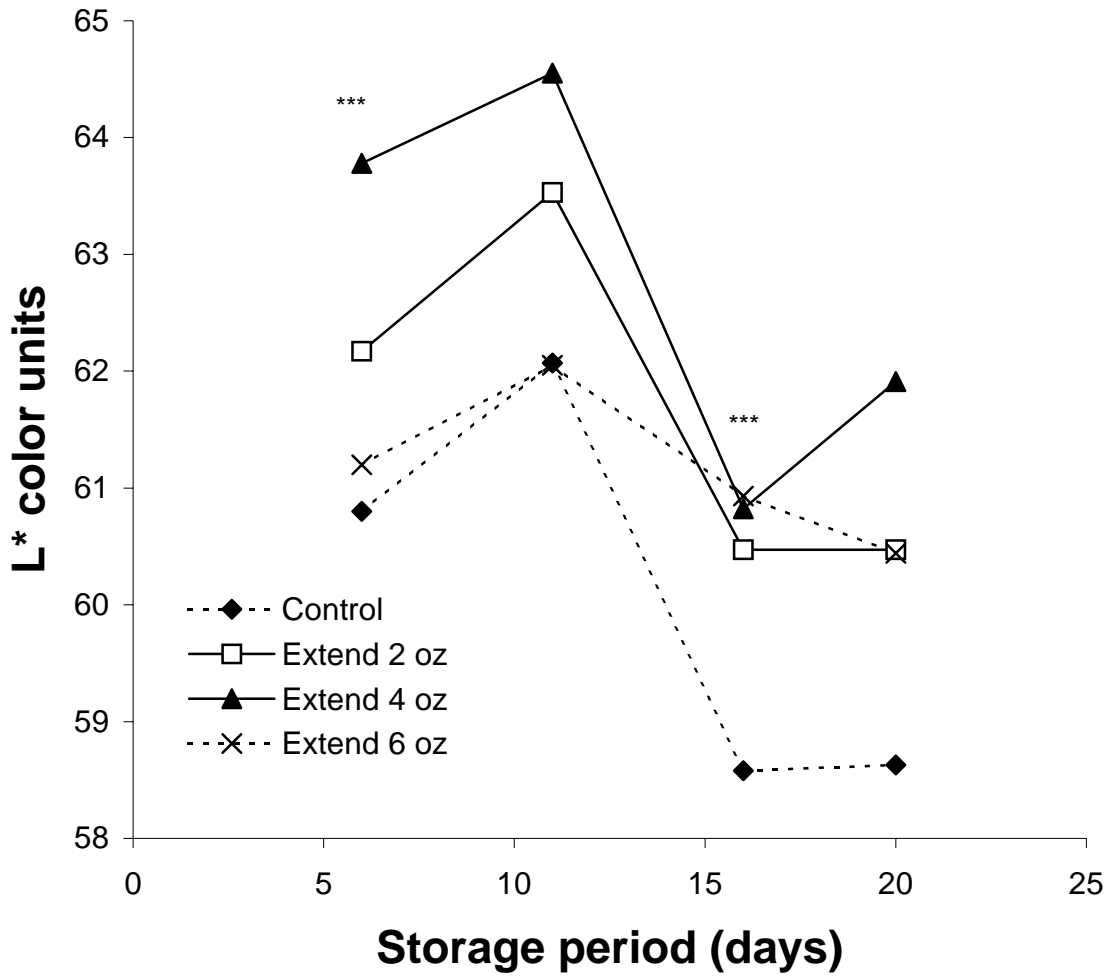


Figure 3. Effect of a single pre-harvest application of Extend® to lettuce grown in Yuma, Arizona on L* color units of fresh-cut lettuce. Rates of the product are per acre. Lower numbers indicate darker color, commonly associated with browning of edges. *** Indicate difference among treatments ($p < 0.05$).