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The Effect of 1-Methylcyclopropene on Postharvest life of Sessile Joyweed (*Alternanthera sessilis*)

R.P.S.S.Rajapakse[a] and C.K. Beneragama[b]*

[a]*Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka*
[b]*Department of Crop Science, Faculty of Agriculture, University of Peradeniya,Peradeniya, Sri Lanka*

Abstract

Sessile Joyweed *(Alteranthera sessilis)* which is commonly known as *Mukunuvenna* in Sri Lanka, is the most widely produced and most popular of nine leafy vegetables cultivated and sold on a commercial scale in Sri Lanka. This is primarily consumed locally, while only a small quantity is exported. However, the shelf life of *Mukunuvenna* is as low about 3-4 days due to leaf yellowing and wilting. Consumers prefer green and turgid leafy vegetables and thus the loss is considerably high after wilting and yellowing. Ethylene is a critical problem in leaf senescence. Minute concentrations such as 1µL/L ethylene can affect leaf yellowing significantly. Thus, an ethylene blocker, 1-Methylcyclopropene (1-MCP), which is now commonly being used in the fruit industry, can be considered as an effective solution for extending the postharvest life of *A. sessilis.* It is not toxic and environmentally friendly thus safe with edible produce. The present study was done, with the objective of investigating effects of 1-MCP on postharvest life and sensory qualities. Two experiments were conducted for several dosages (concentration × time) to investigate the shelf-life performances and processed *A. sessilis* samples were used to check sensory qualities such as taste, smell, texture and colour.

Samples treated with 1-MCP showed high levels of chlorophyll, lower yellowing and higher overall quality. Postharvest life of treated samples increased by 1 full-day (25% increase) under the room temperature. 1-MCP, 5 ppm for 8 hour duration showed promising results. However, the obtained results did not show a specific treatment combination as the best treatment and 1-MCP did not alter the sensory qualities of the processed product.

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* Corresponding author. Tel.: 0718501686; fax: +0-000-000-0000 .
*E-mail address:*chalindab@gmail.com

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1. Introduction

Sessile joyweed *(Alteranthera sessilis)* or *Mukunuwenna* (Sri Lankan common name) is the most widely produced and most popular of nine leafy vegetables cultivated and sold on a commercial scale in Sri Lanka (De Alwis et al., 2006). This perennial herb, which belongs to family Amaranthaceae is a green leafy vegetable with high level of vitamins, minerals and fiber. Due to its taste, medicinal properties and low cost, *Alteranthera sessilis* is consumed by Sri Lankans, several times a week (Wahundeniya, 2008), generating an annual potential net income of Rs. 151,200 per acre. This is primarily consumed locally, while only a small quantity is exported.

The monthly retail and wholesale prices are relatively stable, but the shelf life of *Mukunuvenna* is as low about 3-4 days due to leaf yellowing and wilting. Consumers prefer green and turgid leafy vegetables and thus the loss is considerably high. On the contrary, it is estimated that the postharvest loss of leafy vegetables is, 5% and it is relatively low compared to other perishables (Wahundeniya, 2008). But unaccounted loss at the household level is much higher due to loss of visual quality.

Ethylene is a critical problem in leaf senescence. Even 1µL/L ethylene can affect leaf yellowing significantly. Thus an ethylene blocker, 1-MCP treatment can be considered as an effective solution for extending the postharvest life of *A. sessilis.* Renowned counterfeit argument against 1-MCP is that, it being expensive; 1-MCP is not worth used for low economic value commodities. However, at present, the price of 1-MCP has noticeably reduced; moreover ultra-low quantities are needed as the treatments need minute concentrations. Most importantly, it is environmentally friendly and non-toxic thus safe with edible produce.

1-MCP is used as an ethylene blocker for numerous fruits to prevent ripening. In addition, it is often used to delay flower senescence as many literature suggests. Nonetheless, a very few studies have been conducted to analyze the effect of 1-MCP on green leafy vegetables. Unlike fruits which need ethylene for ripening, the main ethylene activity in the leafy vegetables is enhancing senescence. Thus the aim of this study is to investigate the effect of 1-MCP on postharvest life and sensory qualities of *A. sessilis.*

2. Methodology

The research was conducted in a laboratory at the Department of Crop Science, Faculty of Agriculture, University of Peradeniya in Sri Lanka. The experiments were carried out from the end of August to October 2014 during which the average temperature was 29±2 °C.

A. sessilis bunches were collected from a local producer at the point of harvest and they were treated inside 20 L each, air tight chambers. Three replicates per treatment combination of 100 g bunches were used. Two experiments were conducted for several dosages. Each was a completely randomized design. In the experiment one, 0, 0.5, 1 and 5 ppm were checked with 4 hour and 8 hour durations. In the second, 0, 7.5 and 10 ppm were checked with the same two time durations. In both experiments, 0 ppm or untreated samples were taken as control treatments. Ethylene scrubbing was not implemented as the experiment was carried out simulating normal storage and retail conditions of leafy vegetables. Similarly cooked *A. sessilis* samples were used to check sensory qualities such as, taste, smell, texture and colour.

As calculated parameters, chlorophyll content, percentage weight loss rate, leaf loss rate and total soluble solids content were considered. Refractometer was used to get total soluble solids content, while chlorophyll content was measured Spectrophotometrically. Leaf yellowing, wilting and overall marketable quality was rated using an index from 1-5 (score 1 for the best) as visual attributes. All the measurements were done in open environment under normal light conditions, room temperature and relative humidity, simulating the conditions at a retail seller's. Sensory analysis was done, using a structured questionnaire. All parametric and non-parametric data were analyzed separately using appropriate tests using SAS software.

3. Results and Discussion

3.1. Chlorophyll content

In the first experiment, chlorophyll content per dry mass (mg/g) present from day 1-5 is shown in Fig 1(a). In both, four hour and eight hour treatments, 5 ppm concentration showed the highest chlorophyll a, b and total retention. Second best was 1 ppm concentration. Similarly, when Spinach leaves were treated with 1-MCP, it exhibited higher chlorophyll content retention (Grozette et al, 2010).

As a whole, the effectiveness of 1-MCP treatment depends on several factors such as treatment at the point of harvest, storage in low temperatures, application temperature etc. It was found that, 20-25 ˚C had greater effects in 1-MCP treatment while 5 ˚C had no effective advantage (Grozette et al, 2010). Moreover, success of the 1-MCP treatment on leafy vegetables was apparent only in extreme conditions such as high temperature or exogenous ethylene exposure (Watkins, 2008). In Choi sum, application of 1 ppm exogenous ethylene continuously, accelerated chlorophyll breakdown (Thompson et al, 2003). Thus, in Sri Lankan situation where green leafy vegetables are marketed in high temperature and in ethylene exposed open environment, chlorophyll retention and reduced senescence will be highly advantageous.

Surprisingly, 0.5 ppm for four hour duration in the present study showed chlorophyll amounts reduced even below the control. It has been reported earlier that, use of too low 1-MCP concentrations may increase senescence due to relief from ethylene auto inhibition or may have no effect; 0.1 ppm 1-MCP had no effect on Spinach senescence (Grozeff, 2010). Treatment combinations 5 ppm and 7 ppm in both time durations showed higher chlorophyll retention while both elevated and reduced 1-MCP concentrations had lower chlorophyll retention as shown in Fig 1(b)

3.2. Leaf yellowing, wilting and overall marketable quality

When considering visual attributes of the *A. sessilis* bunches, leaf yellowing was reduced at greater levels; 5 ppm 1-MCP for four hour and eight hour duration reported the lowest yellowing and wilting indices (data not shown). Based on that, overall marketable quality was the highest. In the second experiment, leaf yellowing was minimum in 10 ppm for 4 hour duration and ultimately the overall marketable quality was the highest.

The main causes for leaf yellowing are high temperatures and delays in handling leafy vegetables. It has been found that 1-MCP delays yellowing of green vegetables as well as leafy vegetables. Broccoli is accounted for the only registered non-fruit green vegetable to be treated with 1-MCP to delay yellowing (Watkins, 2008) and in Choy sum and Shanghai buk choy too, 1-MCP delays yellowing and improves overall marketable quality.

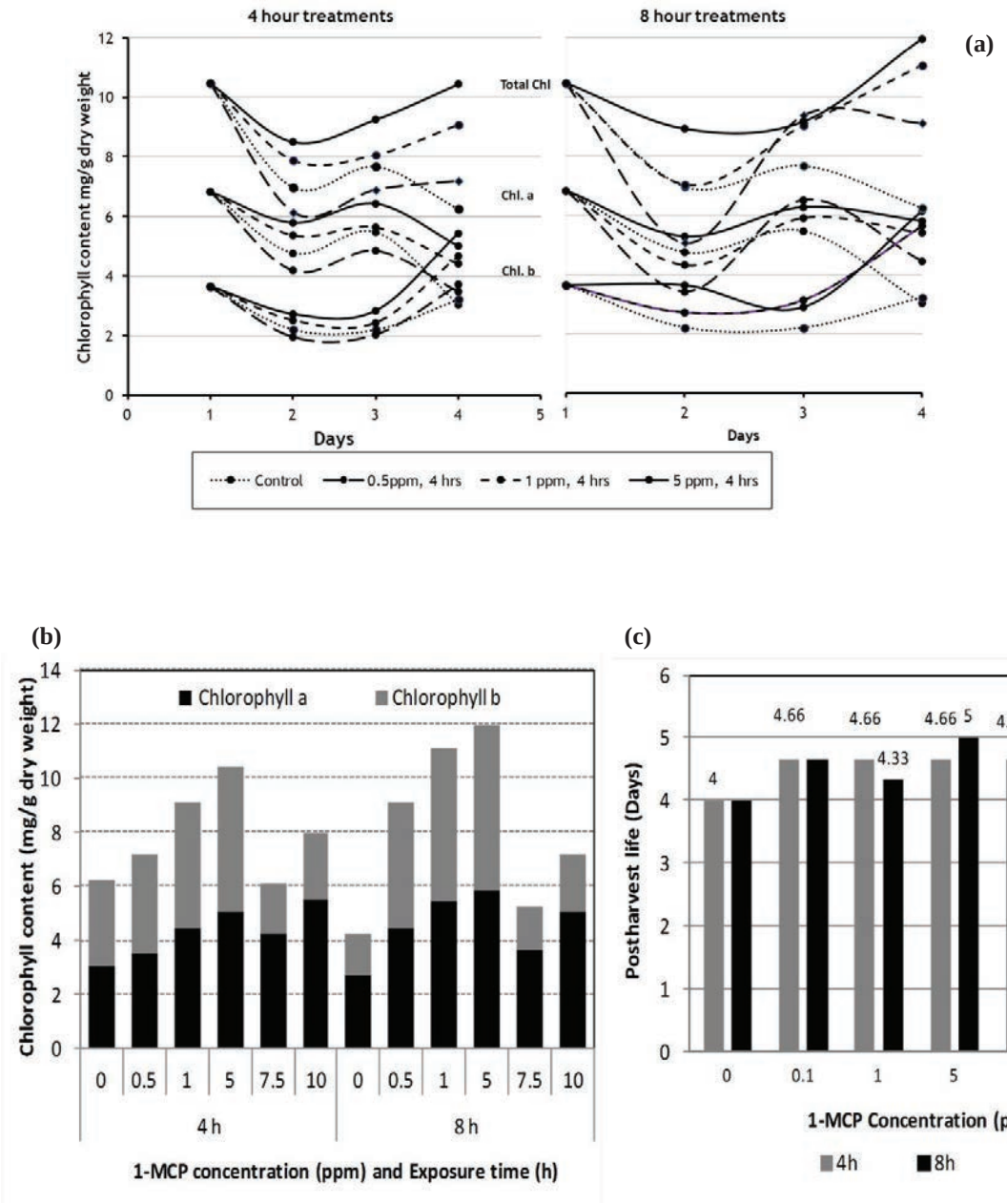

Figure 1: (a) Chlorophyll content through days; (b) Chlorophyll a and b variation with treatments on 04th day; (c) Postharvest life as affected by 1-MCP treatments

3.3. Sensory evaluation

1-MCP is still a new product for edible produce in the world. In Sri Lankan context, it is not used in commercial level but has been used for research purposes at times. Since it is likely to be available in future, broadened horizons in the experiment sector would be beneficial. As green leafy vegetables are consumed as it is (without peeling like vegetables or fruits) considering sensory qualities such as taste, smell and colour is essential. In the sensory evaluation with cooked samples, a vast majority of respondents (89%, n=42) stated that the controlled and treated samples were not different. Among the remaining 11%, majority stated that the difference is only slight. Thus it can be concluded that the treatment with 1-MCP did not alter sensory qualities in *A. sessilis.*

4. Conclusion

1-MCP is effective in extending the postharvest life of *Alteranthera sessilis.* As it reduced yellowing, rate of chlorophyll degradation, increased overall marketable quality and ultimate postharvest life at ambient temperature, may have beneficial results in leafy vegetable marketability in local and export sectors.
Considering all the parameters, 1-MCP 5 ppm for 8 hour duration showed promising results and finally, treatment with 1-MCP did not alter sensory qualities of the processed *A. Sessilis.*

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