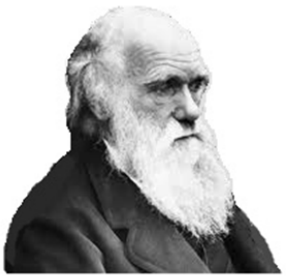
Available online at www.worldnewsnaturalsciences.com



World News of Natural Sciences

An International Scientific Journal

WNOFNS 22 (2019) 151-158 EISSN 2543-5426

Improvement of postharvest quality of cut amaranth (*Amaranthus tricolor* L.) foliage by ethanol

Rafał Piechocki*, Piotr Salachna

Department of Horticulture, Faculty of Environmental Management and Agriculture, West Pomeranian University of Technology, Szczecin, Poland

*E-mail address: rafal.piechocki@zut.edu.pl

ABSTRACT

The response of cut *Amaranthus tricolor* foliage to continuous treatment with 200 $mg \cdot l^{-1}$ 8-hydroxyquinoline citrate (8-HQC) or 2, 4 and 6% ethanol was investigated. Application of ethanol and HQC enhanced the vase-life and final fresh weight. The best quality cut *Amaranthus tricolor* foliage were obtained when the stems held in 4% ethanol. These are the first published results that indicate that ethanol positively improved the postharvest quality of cut *Amaranthus tricolor* foliage.

***Keywords*:** post-harvest longevity, vase solution, *Amaranthus gangeticus*, *Amaranthus tricolor*, 8-HQC

1. INTRODUCTION

The largest genus, *Amaranthus*, contains about 70 species, and several are cultivated as ornamental plants. *Amaranthus tricolor*, known as edible amaranth, joseph's coat, tampala or Chinese spinach, is a very attractive plant with red, yellow and green foliage [1]. It is an upright, bushy annual that typically grows to 100-120 cm tall. *Amaranthus tricolor* can be successfully cultivated in flowerbeds in gardens. However, there is a lack of information of the postharvest of cut *Amaranthus tricolor* foliage.

Several substances have been applied to prolong vase life of the cut stems [2, 3]. 8-hydroxyquinoline citrate (8-Hydroxy-2-quinolinecarboxylic acid; 8-HQC) is commonly used as floral preservatives. Ethanol is known as one of the most efficient chemical factors for extending the vase life of some cut species [4-6] by inhibiting ethylene biosynthesis [7-9].

(Received 12 December 2018; Accepted 27 December 2018; Date of Publication 28 December 2018)

However, limited information is available for cut foliage regarding effects of ethanol. Therefore, the present studies were conducted to determine the effect of ethanol on cut *Amaranthus tricolor* foliage.

2. MATERIALS AND METHODS

Cut stems of *Amaranthus tricolor* 'Red' and 'Burgundy' were grown in unheated high plastic tunnel covered with a double layer of plastic, using standard commercial procedures (**Fig. 1**). All experiments were conducted at the West Pomeranian University of Technology in Szczecin (53°25' N, 14°32' E; 25 m a.s.l.).

Figure 1. Cut *Amaranthus tricolor* stems were harvested at the vegetative stage.

Stems of *Amaranthus tricolor* 'Red' and 'Burgundy' were cut randomly at 8:00-11:00 h to a length of 40 cm and taken immediately to the laboratory within 30 minutes of harvest. After recording the initial fresh weight using an electronic scale electronic (RADWAG PS 200/2000. R2 with an accuracy of 0.001 g) stems were placed into individual glass vases filled with 500 ml water (control), solution with 200 $mg \cdot l^{-1}$ 8-hydroxyquinoline citrate $C_{15}H_{15}NO_8$ (8-HQC) (Merck) or solution with 2, 4 and 6% (v/v) ethanol (Chempur, Poland). Solutions used in study were prepared using tap water in which mean ion concentration ($mg \cdot dm^{-3}$) was as follows: 1.50 $N\text{-}NO_3$, 1.3 P, 6.3 K, 94.7 Ca, 15.5, Mg, 22.0 Na, 22.0 Cl, 0.62 Cu, 0.41 Zn, 1.2 Fe, 196 HCO_3, and 0.65 $mS \cdot cm^{-1}$ electrical conductivity.

Each treatment involved 10 replications per 1 stem. Solutions were not renewed during the trial. The cut *Amaranthus tricolor* 'Red' and 'Burgundy' foliage were kept in a room with controlled environment (21 ±2 ºC, 60-70 % humidity RH, 12 µmol $m^{-2} \cdot s^{-1}$ light intensity) under a daily light for 12 $h \cdot d^{-1}$. The foliage was observed every day during vase period. Vase life was expressed in days. On the day when the decorative value of the foliage was lost, their fresh weight, leaf greenness index (SPAD) and stomatal conductance were assessed. SPAD was measured with an optical device Chlorophyll Meter SPAD 502 (Minolta, Japan) and stomatal conductance was assessed with SC1 porometer (Dekagon Devices, USA).

Porometer effectively measures resistance between the leaf and the first humidity sensor and the first and second sensors.

Results were statistically verified using the analysis of variance model using Statistica 13.0 software, and the obtained means were grouped using Tukey's test at the significance level $p \leq 0.05$.

3. DISCUSSION AND RESULTS

All ethanol treatments significantly ($p \leq 0.05$) markedly extended vase life of cut *Amaranthus tricolor* 'Red' (**Fig. 2**) and 'Burgundy' (**Fig. 3**) foliage compared to the control (tap water). The longest vase-life were obtained with cut stems placed in 4% ethanol. Stems placed in 8-HQC also had longer vase-life compared to tap water (**Fig. 4**). Recent study has also established the effectiveness of ethanol for vase life extension of cut carnation [9-11], roses [12], chrysanthemum [13, 14], *Tweedia caerulea* [15], *Anthurium andreanum* [16] and *Protea* sp. [17]. The improvement in vase life in solution containing ethanol might be due to the fact that ethanol probably protecting cut foliage against water deficit stress and ethylene action [9, 12, 15].

Figure 2. Visible effect of 200 $mg \cdot l^{-1}$ 8-hydroxyquinoline citrate (8-HQC) or ethanol on the display quality of cut *Amaranthus tricolor* 'Red' foliage after 48 h of storage. Left to right: nontreated control (tap water), 8-HQC, 2, 4, and 8% ethanol.

Figure 3. Visible effect of 200 mg·l^{-1} 8-hydroxyquinoline citrate (8-HQC) or ethanol on the display quality of cut *Amaranthus tricolor* 'Burgundy' foliage after 48 h of storage. Left to right: nontreated control (tap water), 8-HQC, 2, 4, and 8% ethanol.

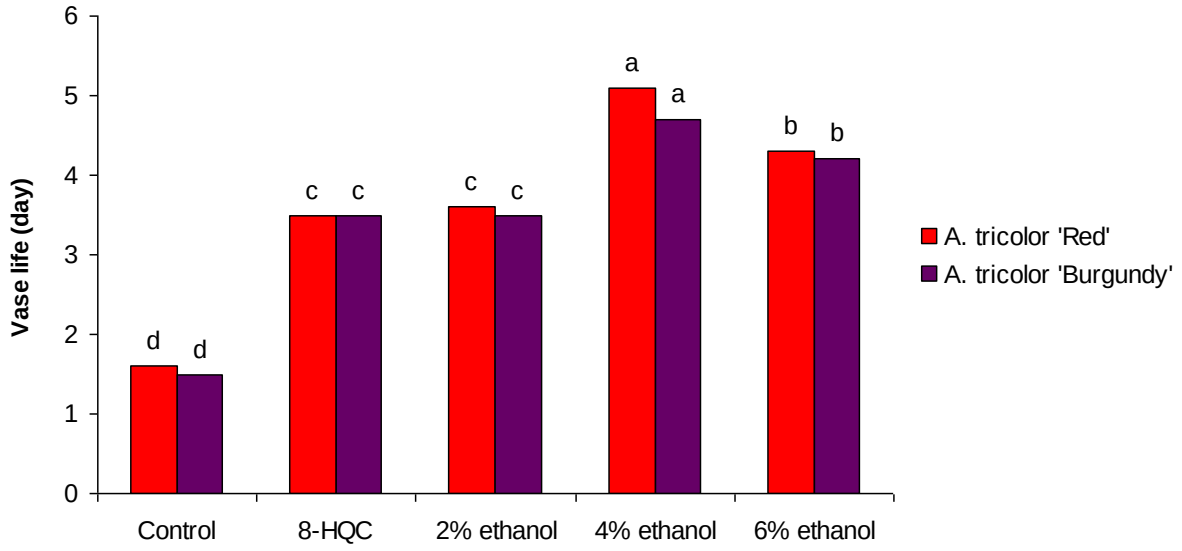


Figure 4. Effects of 200 mg·l^{-1} 8-hydroxyquinoline citrate (8-HQC) or ethanol (2, 4 and 8%) on the vase life of cut amaranth (*Amaranthus tricolor*) 'Red' and 'Burgundy' foliage. A different letters above each bar indicate a significant difference between treatments at $p \leq 0.05$. Values are means (n = 10).

During the vase life evaluation period, the change in fresh weight of cut amaranth foliage was the highest in the control. The 6% ethanol treatment best maintained relative fresh weight of cut amaranth 'Red' foliage (**Fig. 5**).

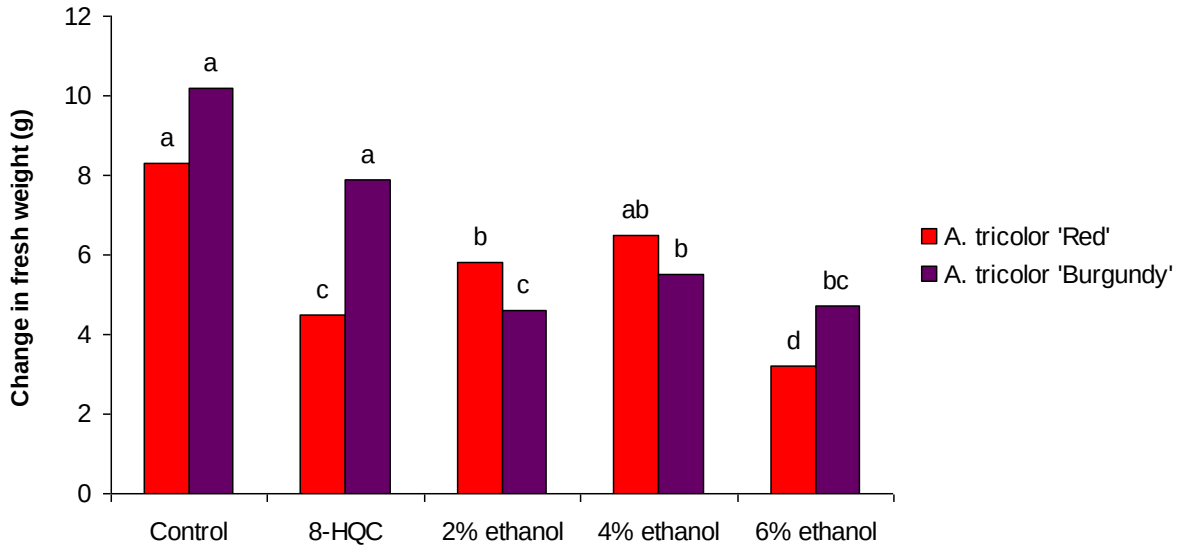


Figure 5. Effects of 200 mg·l^{-1} 8-hydroxyquinoline citrate (8-HQC) or ethanol (2, 4 and 8%) on the change in fresh weight (initial FW – final FW) of cut amaranth (*Amaranthus tricolor*) 'Red' and 'Burgundy' foliage. A different letters above each bar indicate a significant difference between treatments at $p \leq 0.05$. Values are means (n = 10).

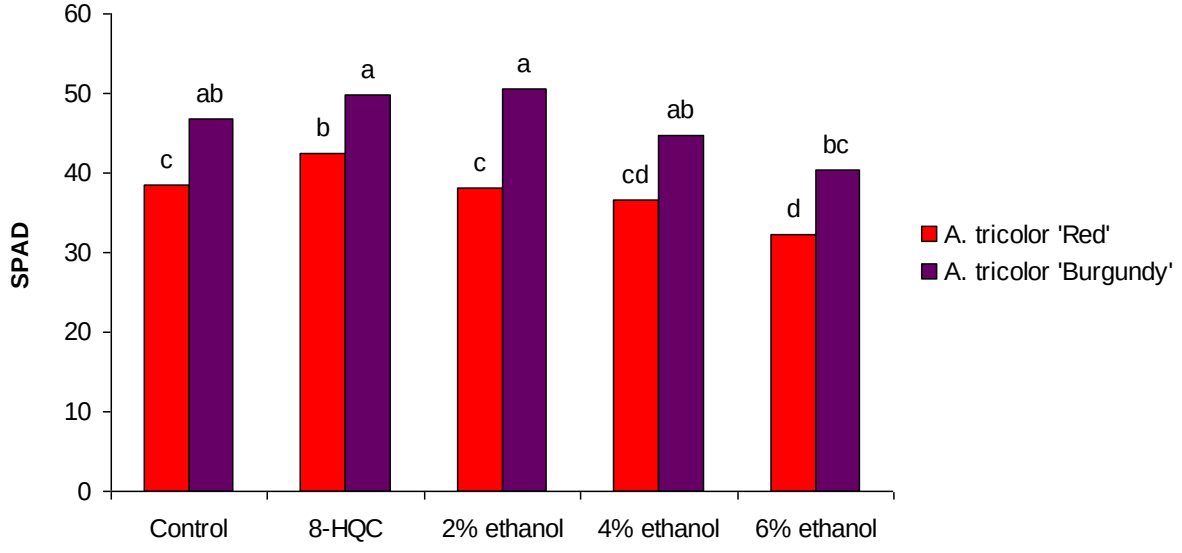


Figure 6. Effects of 200 mg·l^{-1} 8-hydroxyquinoline citrate (8-HQC) or ethanol (2, 4 and 8%) on the relative leaf chlorophyll concentration (SPAD value) of cut amaranth (*Amaranthus tricolor*) 'Red' and 'Burgundy' foliage. A different letters above each bar indicate a significant difference between treatments at $p \leq 0.05$. Values are means (n = 10).

Results showed a significant effect of different preservative solution on relative leaf chlorophyll concentration (SPAD). Relative leaf chlorophyll of cut amaranth (*Amaranthus tricolor*) 'Red' and 'Burgundy' foliage was significantly decreased by addition of 6 % ethanol. Only stems held in 200 mg·l^{-1} 8-hydroxyquinoline citrate (8-HQC) had more relative leaf chlorophyll concentration (SPAD) than controls (**Fig. 6**).

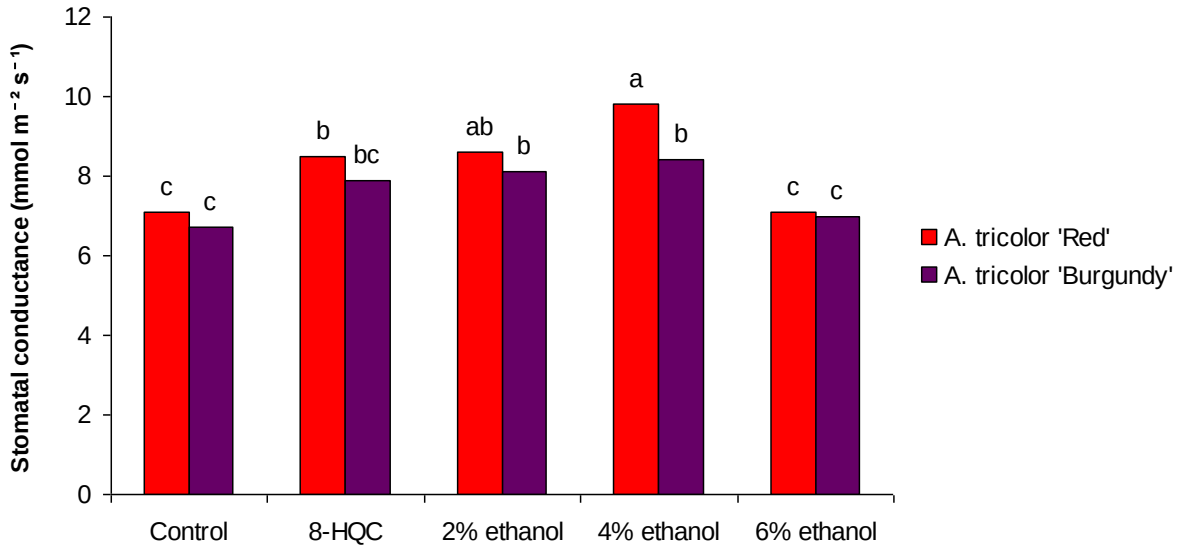


Figure 7. Effects of 200 mg·l^{-1} 8-Hydroxy-2-quinolinecarboxylic acid (8-HQC) or ethanol (2, 4 and 8%) on the stomatal conductance of cut amaranth (*Amaranthus tricolor*) 'Red' and 'Burgundy' foliage. A different letters above each bar indicate a significant difference between treatments at $p \leq 0.05$. Values are means (n = 10).

Stomatal conductance is an important indicator of stomatal control of water uptake and assimilation. All the treatments except for 6% ethanol, led to more stomatal conductance than controls (**Fig. 7**). We speculate that this height concentration of ethanol may be toxic to cut amaranth foliage.

4. CONCLUSIONS

This research showed that ethanol significantly extended the vase life of cut foliage *Amaranthus tricolor* 'Red' and 'Burgundy' compared with the control. The change in fresh weight and stomatal conductance were reduced as a result of using ethanol. As far as we known, this is the first time the ethanol could be used as a vase solution for improving the postharvest quality of cut *Amaranthus tricolor* foliage.

References

[1] Khandaker L, Akond AM, Ali MB, Oba S. Biomass yield and accumulations of bioactive compounds in red amaranth (*Amaranthus tricolor* L.) grown under different colored shade polyethylene in spring season. *Scientia Horticulturae* 123 (2010) 289−294.

[2] Byczyńska A, Salachna P. Effects of colloidal silver on vase life of cut chrysanthemum. *World Scientific News* 69 (2017) 239−243.

[3] Salachna P, Byczyńska A. Effect of nitric oxide and production location on vase life of cut *Eucomis* 'Sparkling Burgundy' flowers. *World Scientific News* 83 (2017) 229−234.

[4] Bazaz AM, Tehranifar A. Effect of ethanol, methanol and essential oils as novel agents to improve vase-life of *Alstroemeria* flowers. *Journal of Biodiversity and Environmental Sciences* 5 (2011) 41−46.

[5] Podd LA, Van Staden J. Physiological response and extension of vase life of cut carnation flowers treated with ethanol and acetaldehyde. I. Chlorophyll content and carbohydrate status. *Plant Growth Regulation* 38 (2002) 99−105.

[6] Kumar N, Srivastava GC, Dixit K. Effect of ethanol plus sucrose on the vase-life of cut rose (*Rosa hybrida* L.). *The Journal of Horticultural Science and Biotechnology* 83 (2008) 749−754.

[7] Farokhzad A, Khalighi A, Mostofi Y, Naderi R. Role of ethanol in the vase life and ethylene production in cut Lisianthus (*Eustoma grandiflorum* Mariachii. cv. Blue) flowers. *Journal of Agriculture and Social Sciences* 4 (2005) 309−312.

[8] Heins RD. Inhibition of ethylene synthesis and senescence in carnation by ethanol. *Journal of the American Society for Horticultural Science* 105 (1980) 141−144.

[9] Pun UK, Rowarth JS, Barnes MF, Heyes JA. The role of ethanol or acetaldehyde in the biosynthesis of ethylene in carnation (*Dianthus caryophyllus* L.) cv. Yellow Candy. *Postharvest Biology and Technology* 21 (2001) 235-239.

[10] Heins RD, Blakely N. Influence of ethanol on ethylene biosynthesis and flower senescence of cut carnation. *Scientia Horticulturae* 13 (1980) 361−369.

[11] Zahra Karimian Fariman and Ali Tehranifar. Effect of essential oils, ethanol and methanol to extend the vase-life of carnation (*Dianthus caryophyllus* L.) flowers. *Journal of Biological and Environmental Sciences* 5(14) (2011) 91−94

[12] Borda AM, Clark DG, Huber DJ, Welt BA, Nell TA. Effects of ethylene on volatile emission and fragrance in cut roses: The relationship between fragrance and vase life. *Postharvest Biology and Technology*, 59 (2011) 245−252.

[13] Petridou M, Voyiatzi C, Voyiatzis D. Methanol, ethanol and other compounds retard leaf senescence and improve the vase life and quality of cut chrysanthemum flowers. *Postharvest Biology and Technology* 23 (2001) 79−83.

[14] Khokhar M, Mukherjee D. Regulation of lipoxygenase and superoxide dismutase activities and longevity of chrysanthemum cut flowers by ethanol and methanol. *Indian Journal of Horticulture* 70 (2013) 76−81.

[15] Pun UK, Niki T, Ichimura K. Ethanol reduces sensitivity to ethylene and delays petal senescence in cut *Tweedia caerulea* flowers. *Plant Growth Regulation* 69 (2013) 125−130.

[16] Thawiang N, Buanong M, Kanlayanarat S. Effect of ethanol on postharvest quality of cut anthurium flowers (*Anthurium andraeanum* L. Cv. Marshall). *Acta Horticulturae* 755 (2007) 419−423.

[17] Windell NE, Stephens IA, Jacobs G, Hoffman L. Effect of ethanol vapour on leaf blackening of selected *Protea* species. *Acta Horticulturae* 869 (2010) 135−139.