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Yi-Hu Xiao; Hao-Ru Tang; Cong Ge; Fan Mo; Nan-Yu Li; Ya Luo ✉



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Effect of Bamboo Vinegar on Cut Flowers of *Zantedeschia aethiopica*

Yi-Hu Xiao¹, Hao-Ru Tang¹, Cong Ge¹, Fan Mo¹, Nan-Yu Li¹ and Ya Luo^{1, a)}

¹College of Horticulture, Sichuan Agricultural University, Chengdu 611130, Sichuan, China

^{a)}Corresponding author: luoya945@163.com

Abstract. The cut flowers of *Zantedeschia aethiopica* were selected as materials to study the effect of six different concentrations bamboo vinegar on the preservation of cut flowers of *Zantedeschia aethiopica*. The vase life, water balance value, soluble sugar, soluble protein and MDA content were tested. The results showed that bamboo vinegar at 1000~1500 times could effectively decrease the loss of water, slow the rate of decline of soluble sugar and protein content and the rate of generation of MDA of cut flowers during vase holding, thus extending the vase life of cut *Zantedeschia aethiopica* flowers, especially the 1500 times is better. In all, bamboo vinegar of proper concentration can delay the senescence and extend florescence of cut *Zantedeschia aethiopica* flowers.

INTRODUCTION

Zantedeschia aethiopica, also known as water taro, water pack flowers and guanyin lotus, is a perennial herb bulb flower in the family of tiannanxing [1]. *Zantedeschia aethiopica* - shaped unique, white large flower bracts, is an important cut flower at home and abroad. It is easy to see the wilting of the bracts and the early appearance of pollen when the cut flowers of *Zantedeschia aethiopica* are harvested and during vase holding, which shortens the ornamental period and reduces the ornamental quality. At present, domestic researches on the preservation technology of cut flowers of *Zantedeschia aethiopica* are very few, and the commonly used cut flowers preservation agent mostly contains Ag⁺, which is not only expensive, but harmful to human body, and easy to pollute the environment [2]. Therefore, the search for efficient, convenient, pollution-free and low-cost fresh liquid combination formula is a new direction of current research on fresh cut flowers.

Bamboo vinegar liquid is a light yellow liquid recovered from bamboo during carbonization. It is a mixture of about 300 ingredients, with organic content reaching about 8% [3]. At present, bamboo vinegar is widely used in agriculture, food preservation and health care because of its environmental protection [4-5]. In regard to the preservation of cut flowers, it has been reported that bamboo vinegar has positive effects on cut flowers such as Chinese rose, chrysanthemum and African chrysanthemum [6], but whether bamboo vinegar has the same effect on the cut flowers of *Zantedeschia aethiopica* has not been reported. *Zantedeschia aethiopica* during test by measuring vase life of cut flower vase, water balance value, soluble protein, soluble sugar and malondialdehyde content changes, the study of different concentrations of the bamboo vinegar liquid and 8-hydroxyquinoline (8-HQ) (CA) fresh liquid to *Zantedeschia aethiopica* cut flower preservation effect, so as to cut flowers fresh bamboo vinegar liquid in the reasonable application to provide theoretical support.

MATERIALS AND METHODS

Materials and reagents

168 cut flowers of *Zantedeschia aethiopica* were purchased. Then they were immediately transported back to the laboratory and selected the buds that grew basically the same, had similar quality (stem diameter, length, bud size,

open degree) and were not open as the test materials. After placing the sample into distilled water with the oblique cut flower diameter of 40 cm, temporarily put distilled water to use.

Treatment Method

A total of 8 treatments were tested, each of which diluted bamboo vinegar raw solution to 500 times (1), 600 times (2), 700 times (3), 800 times (4), 1000 times (5) and 1500 times (6), and 3% sucrose +150mg/ 18-hydroxyquinoline citrate (8-HQC) (CK₁) and distilled water (CK₂) were used as the control. The experiment was repeated 3 times for each treatment of 7 fresh cut flowers.

Insert the flower material, which is in distilled water, into the bottle containing the prepared freshener (A small ball of absorbent cotton is stuffed around the mouth of the bottle), placed in a laboratory, 20 to 25 °C at room temperature, observe and record the open and the ageing process. All physiological and biochemical indexes were measured every two days at the same time.

Data Analysis

Statistical analysis was performed using Excel and SPSS 20.0 data processing system.

RESULTS

Effects of Different Treatments on the Vase Life and Water Balance Value of Cut *Zantedeschia aethiopica* Flowers

Except treatments NO.3~6, all other treatments showed negative water balance value on the fourth day of vase. (TABLE 1) In addition, NO.3~6 treatments, especially NO.6 treatment had the best fresh-keeping effect and the best ornamental quality. The negative value of water balance did not appear until the 6th day of VASE, and the vase life reached 13 days, 3 days and 4 days longer than CK₁ and CK₂, and the difference with other treatments was extremely significant.

TABLE 1. Effects of different treatments on the vase life and water balance value of cut *Zantedeschia aethiopica* flowers

NO.	vase life /d	water balance value / g										
		2d	3d	4d	5d	6d	7d	8d	9d	10d	11d	12d
1	8e	3.83	0.71	-0.5	-0.68	-0.22	-4.07	-0.35	-	-	-	-
2	8e	4.14	0.76	-0.054	-0.27	-0.59	-0.51	-1.72	-	-	-	-
3	8e	4.88	0.55	0.067	-0.08	-0.47	-1.77	-2.06	-	-	-	-
4	10c	4.45	0.61	0.15	-0.23	-0.18	-1.44	-0.15	-1.30	-1.15	-	-
5	12b	4.19	0.59	0.12	-0.045	-0.42	-0.52	-1.21	-2.07	-2.26	-1.21	-1.66
6	13a	3.95	0.51	0.043	0.019	-0.12	-0.32	-1.59	-2.41	-1.44	-1.04	-1.47
CK ₁	10c	1.32	0.36	-0.27	-0.17	-0.99	-0.18	-0.37	-1.95	-4.42	-	-
CK ₂	9d	4.41	0.47	-0.18	-0.095	-1.1	-1.41	-1.9	-	-	-	-

Note: CK₁ was 3% sucrose +150mg/L 8-HQC, CK₂ was distilled water; Small letters stand for significant at 0.05 level; “-” means no ornamental value. The same below.

Effects of Different Treatments on the Soluble Sugar Content in Cut *Zantedeschia aethiopica* Flowers during Vase Holding

The variation of soluble sugar content of cut *Zantedeschia aethiopica* flowers treated with different concentrations of bamboo vinegar was basically consistent with that of the control group, and the overall trend of decline was obvious, especially that of the decline four days before vase, and then it tended to be flat. (TABLE 2) Among the 8 treatments, NO.1~3 showed the most obvious decline in soluble sugar content of *Zantedeschia aethiopica* and the fastest aging rate of cut flowers. On the fourth day, the soluble sugar content decreased by 33.13%, 38.93% and 33.11% respectively, compared with that on the second day. The contents of soluble sugar in the treatment of NO.4~6 and the control group decreased steadily. The contents of soluble sugar on day 4 decreased by 20.13%, 16.44%, 16.82%, 16.07% and 19.44%, respectively, compared with that on day 2. Among the 8 treatments, the soluble sugar decomposition rate of NO.5 (1000 times bamboo vinegar) and NO.6 (1500 times bamboo vinegar) was slow and stable, and the ornamental value of cut flowers was the highest, while NO.6 treatment had the best effect.

TABLE 2. Effects of different treatments on the soluble sugar content in cut *Zantedeschia aethiopica* flowers during vase holding

NO.	soluble sugar content /%						
	2d	4d	6d	8d	10d	12d	13d
1	32.6	21.8	20.7	19.8	-	-	-
2	29.8	18.2	16.8	19.2	-	-	-
3	29.6	19.8	17.2	19.7	-	-	-
4	29.8	23.8	22.4	23.6	21.8	-	-
5	29.8	24.9	23.7	24.2	23.4	17.8	-
6	32.7	27.2	24.9	25.1	24.7	19.2	18.2
CK ₁	30.5	25.6	20.2	19.3	18.2	-	-
CK ₂	32.4	26.1	23.6	24.8	23.5	-	-

Effects of Different Treatments on the Soluble Protein Content in Cut *Zantedeschia aethiopica* Flowers during Vase Holding

With the extension of the time of vase, the changes of soluble protein content in the cut flowers of *Zantedeschia aethiopica* presented an overall downward trend (TABLE 3). Four days before vase, the soluble protein content of each treatment decreased sharply, and then showed the characteristic of volatility change that increased or decreased and increased again. Among the 8 treatments, NO.5~6 had the best fresh-keeping effect, and the soluble protein was the slowest to decompose. 12 and 13 days after vase, the content decreased by 23.72% and 16.46%, respectively, compared with the control group.

TABLE 3. Effects of different treatments on the soluble protein content in cut *Zantedeschia aethiopica* flowers during vase holding

NO.	soluble protein content /mg·g ⁻¹						
	2d	4d	6d	8d	10d	12d	13d
1	14.5	4.8	4.9	2	-	-	-
2	16.9	4.2	6.2	4	-	-	-
3	15.9	4	7	4.3	-	-	-
4	16.9	7	8.4	6.1	5.9	-	-
5	15.6	5.9	9.9	8.9	6.1	11.9	-
6	15.8	5.9	10.1	9	6.2	12.6	13.2
CK ₁	15.8	5.9	10.2	7.7	5.9	-	-
CK ₂	15.9	4.1	7.9	2.4	5.4	-	-

Effects of Different Treatments on MDA Content in Cut *Zantedeschia aethiopica* Flowers during Vase Holding

The content of malondialdehyde in fresh water with different proportions showed an upward trend (TABLE 4). In vase day 8, NO. 1~3 processing of malondialdehyde content were higher than the control group, NO. 5~6 were significantly lower than other treatment, shows a high concentration of bamboo vinegar liquid (500 ~ 700 times) can promote the formation of malondialdehyde, accelerate the aging of cut flowers, and low concentration of bamboo vinegar liquid (1000 and 1500 times) can slow down the accumulation of MDA, delay the degree of membrane injury and thus extend the vase holding of *Zantedeschia aethiopica*.

TABLE 4. Effects of different treatments on MDA content in cut *Zantedeschia aethiopica* flowers during vase holding

NO.	MDA content / $\mu\text{mol}\cdot\text{g}^{-1}$						
	2d	4d	6d	8d	10d	12d	13d
1	3.4	4.1	4.5	6	-	-	-
2	3.3	4.7	4.9	5.3	-	-	-
3	3.4	4.8	4.9	5.4	-	-	-
4	3.4	4.2	4.8	5	5.8	-	-
5	3.4	4.1	4.2	4.3	4.4	5	-
6	3.8	4.2	4.3	4.5	4.6	5.1	5.6
CK ₁	3.3	4.6	4.7	4.9	5.7	-	-
CK ₂	3.3	4.7	4.8	5.3	5.6	-	-

DISCUSSION

At the beginning of vase, cut *Zantedeschia aethiopica* flowers have good water absorption capacity. However, in the later period of vase, water loss is greater than water absorption, and the water balance in the body is damaged. The ornamental quality of *Zantedeschia aethiopica* is directly affected.

At present, there have been a few reports about the research on the preservation of cut flowers by bamboo vinegar solution. The optimal concentration range of different ornamental plants is different. The application of 500~1000 times bamboo vinegar solution is applicable to the preservation of roses, carnations, African chrysanthemums, chrysanthemums and tulip cut flowers [6-7]. In this experiment, 1000 and 1500 times bamboo vinegar had positive effect on the preservation of cut *Zantedeschia aethiopica* flowers, especially the best preservation effect of 1500 times bamboo vinegar. The bottle of cut flower of *Zantedeschia aethiopica* treated with this preservative has the longest life, reaching 13 days. The water balance value in this formula was negative for the longest time, and the content of soluble sugar and soluble protein decreased and MDA increased slowly compared with other treatments. Therefore, the proper concentration of bamboo vinegar can delay the senescence and prolong the ornamental period. CK₁ is a combination formula of traditional fresh cut flower preservatives commonly used. However, the effect of CK₁ on fresh cut flowers of *Zantedeschia aethiopica* is less than that of bamboo vinegar solution of 1000 times and 1500 times, which may be the reason why *Zantedeschia aethiopica* is sensitive to traditional fungicide8-HQC.

In the process of experiment, it was also found that the fresh cut flowers of *Zantedeschia aethiopica* were prone to the phenomenon of decaying flower stalks during the process of vase. Sometimes this phenomenon even occurred when the bracts of *Zantedeschia aethiopica* were not bursting, which seriously affected the freshness of the flowers. Whether this phenomenon is caused by mechanical injury during transportation or other reasons remains to be further studied.

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