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Effect of citric acid on freshness preservation in cut sunflowers (*Helianthus annuus* L.)

Abstract

Cut sunflower possess potential market economic value, its preservation need resolve urgently. In our experiment, three citric acid concentration gradient (50, 100, 150 mg·L^{-1}) had been set, and sunflower 'Big flower' was employed as material. The experimental results show that: treatment A (50 mg·L^{-1} citric acid) was the best preservative in this experiment, the effect of high concentration (150 mg·L^{-1}) was the same as control (no citric acid addition). The preservation effect of concentration (100 mg·L^{-1}) was better than treatment C and control, but not so good as treatment A. Our result both provide an economical and effective preservative for consumers, and reduce the preservative cost.

Keywords: *Helianthus annuus*, citric acid, freshness preservation, cut flowers

Volume 3 Issue 4 - 2019

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Received: August 09, 2019 | **Published:** August 26, 2019

Introduction

Helianthus annuus is an annual dicotyledonous plant, herbaceous, which belonged to Compositae family.[1] Because of its themo- and photo-insensitive, it can be grown throughout the year in sub-tropical and tropical countries. Some of the cultivars have good ornamental traits, such as flower disc, bright petal colors, and wonderful flower language. Therefore, it were planted worldwide, expanded its territory swiftly from North America to other countries.

Cut sunflower is an important consumption form all over the world. Its market capacity is increasing every year. Especially in China, red, orange and yellow are the most popular colors, which attribute to our traditional culture. In general, one cut sunflower can earn five yuan (RMB), its cultivation cycle almost three months. Furthermore, it can be collected four times in the same farmland yearly.[2] There is an promising market for cut sunflower in China, as soon as the complex geographical resources of our country, such as Hainan, Guangxi, Guangdong, Fujian, Yunnan provinces, are concerned.

Cut sunflower preservation is an problems to be solved urgently. Herbaceous stems can be attacked by microbes, lead to stem rot so easily those lose the function of water absorption and transport, then cut flower vase life was ended. Although preservation of other cut flower had been carried out already, different species have unique characters, appropriate, economical and effective preservatives are desiderata for cut flower. To summarize, prolong the vase life of sunflower is an essential target. So our pilot tests to prolongate sunflower vase life have practical value for cut flower consumers and flower shop owners.

Materials and methods

Materials

The experimental material, *Helianthus annuus* 'Big flower', was planted in Yangtze University campus in 2018. *H. annuus* flowers were cut from 9 am to10 am on 26th of October when the ligulate petals unfolding. Flower diameter (5-6cm) and flower branch length (30-40cm) need meet the same criteria. Flower branch were cut into 30 cm length with45 degree incline in preservation liquid and keep 3 leaves as soon as it were taken into laboratory.

Methods

Three concentration gradients (50, 100, 150 mg·L^{-1}) of citric acid (the pH value of citric acid preservation solution was 6.0) and one distilled water blank control were set up in this experiment (Table 1). one *H. annuus* flower per plastic water bottle. Indoor environmental conditions were as follow, Room temperature 16-24℃, humidity 50%-70%, scattered light in daytime and keep natural dark from 9 pm to 7 am of the next day. At 10 am, the indicators of preservation of sunflower cut flowers were detected every day.

Table 1 Design of preservatives treatment

Treatments	Combination
A	3% sucrose+50mg·L^{-1} citric acid+0.1g·L^{-1}GA
B	3% sucrose+100mg·L^{-1} citric acid+0.1g·L^{-1}GA
C	3% sucrose+150mg·L^{-1} citric acid+0.1g·L^{-1}GA
CK	distilled water

From the first day of experiment beginning, the aging of cut flowers, such as curvature or blueness, wilting and loss of ornamental value, was recorded. When the flowers appear withered, curved or blued, the days of loss of ornamental value are calculated.[3]

Preservative was added daily to keep 400ml per plastic bottle. The preservative loss of cut sunflower was measured every two day. It had been observed that the changes from first day to the end day when the ornamental value is lost. The leaf, petal, stem and stem base of sunflower were observed every two days and the relevant photos were taken. The effect of different preservative solutions had been evaluated based on prolonged vase days and ornamental value keeping ability.

Results

Effect of preservatives on vase life and quality

As for different treatments, the loss of preservative was showed in Figure1. The treatments maintained high preservative loss compared with control. The minimum (3.58 ml) and peak values (11.58 ml) presented on the 5th and 7th day, considering the overall variation trend of A, B, C and control.

The vase life of treatment A and B were longer than control there was no difference between treatment C and control (Table 2). Observation of morphological changes (Figure 2) was consistent with data in table 3. The bottle life of treatment A was 10 days, which longer than control, up to 3 days. Treatment A was the best, which maintained bright petal color on the 7st and 10st day just as fresh cutting. Reversely, the leaves of treatment B, C and control began to sag on the fifth day; the petals of control appeared brown spots on the top of petals on the seventh day; the leaves and petals of treatment A were much better than other treatments regarding of fresh-keeping on the tenth day. The leaves of treatment C and control had withered and detached (Figure 2), (Table 3).

Treatment A was the best in this experiment condition, which can prolong vase life 3days or 5 days. The appropriate citric acid concentration was so vital to preservation of cut sunflower that too high (150 $mg \cdot L^{-1}$) to maintain vase life.

Table 2 Effects of Preservatives on the Lifetime of Sunflower Bottling

Treatments	Vase life (days)
A	10
B	9
C	7
CK	7

Table 3 Effects of different treatments on leaves, petals and stems of cut sunflower

Days	Treatment	Changes of leaves, petals and stems
5	A	slightly curled both for leaf and leaf margin
	B	Leaf slightly curled, petal normal
	C	Leaf slightly curled, few petals rolled inward, pollen scattered
	CK	patchy blight in leaves, or brown dots appears at petal apex
7	A	leaf margin slight-blight patch, small brown dots at petal apex, stamen black
	B	leaf margin arose blight patch, brown dots up to 1/3 flowers
	C	Leaves down curl and blight, distinct brown dots at petal apex
	CK	Leaves patch-blight, brown dots at petal apex, ornamental value dropping
10	A	No distinct senescence, keep ornamental value still
	B	flower head drooping, petals detach, lose ornamental value
	C	Petal wilting up to 88%, stems rotten, no ornamental value
	CK	Petals detach , flower head drooping, no ornamental value

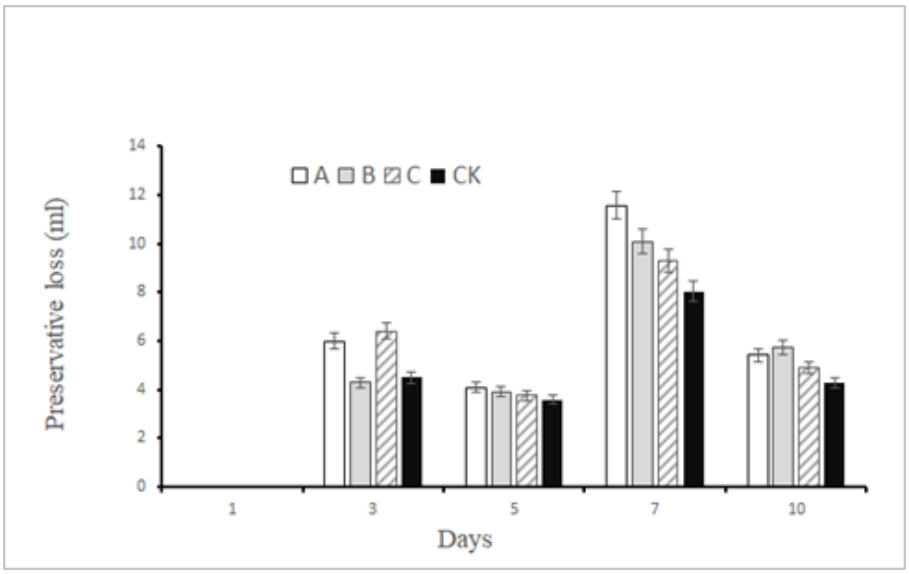

Figure 1 Effects of different treatments on loss value of cut sunflower.

Citation: Sun TZ, Cheng SS, Wu WJ, et al. Effect of citric acid on freshness preservation in cut sunflowers (*Helianthus annuus* L.). *Horticult Int J.* 2019;3(4):201–204. DOI: 10.15406/hij.2019.03.00131

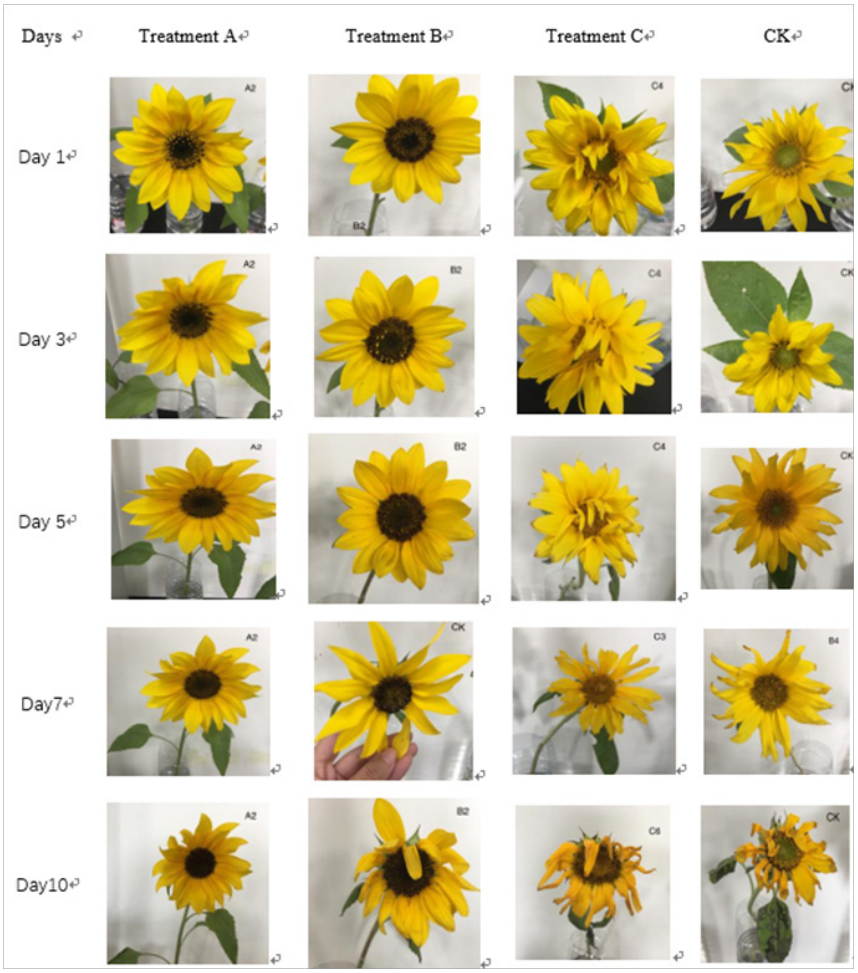

Figure 2 Effects of different treatments on ornamental value keeping capacity.

Discussion

The preservative loss of treatment A was the highest one and the vase life was the longest. Normal physiological state need keep water potential balance, lower water potential out of plant always lead to water loss from plant cell. In addition, high concentration of aqueous solution just as constructed abiotic stress, which do no good to plant, especially to cut flower. As for cut flowers,[3] the cells expansion pressure maintain at a certain extent, i.e. the basic water balance of the plant, they can maintain normal physiological metabolism. This document explained the phenomenon in our experiment.

Temperature(Tm)[4] was an main factor on cut sunflower vase life, the best storage Tm was 0-1℃, high temperature accelerate its aging significantly, but indoor Tm between 15℃- 24℃ in Jingzhou city, Hubei province. This experimental result just suitable for cut sunflower preservation in autumn. If in summer, high temperature is more suitable for the overactive microorganisms, which will result in cutting flowers accelerated corruption, especially for herbaceous stems like sunflower. In the second experiment, when indoor temperature above 30℃, we found out vase life (in summer) was shorter than the first one (in autumn). In summer, in order to inhibit stem rotten, some related bacteria and fungi inhibitor must add in order to slow down the speed of stalk decay.

Conclusion

We did draw the conclusion that 50 $mg \cdot L^{-1}$ citric acid was the effective preservative in this experiment, through evaluating the preservative loss, morphological changes in the extent of leaves blight, petal color and blight, flower curvature and so on. Reasonable preservative, must include suitable ingredient and dosage, which can avoid the waste of resources and gain the best effect with the lowest cost. Furthermore, environment-friendly preservative should be the urgent demand of cut flower preservation in future.

Funding

None.

Acknowledgements

None.

Conflicts of interest

The authors declares there is no conflicts of interest.

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