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Effects of Floral Preservatives on the Vase Life of Orchid (*Epidendrum radicans* L.) Cut Flowers

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Abstract: Orchid (*Epidendrum radicans* L.) is one of the most precious flowers that have the potential of longest vase life in the cut flower industry and it thrives well in the tropics and sub-tropics. This experiment was conducted to determine the effect of different floral preservative on the vase life of orchids. Four floral preservative solutions, Chrysal (commercial floral preservative) and different homemade floral preservatives: vinegar, apple juice and laundry bleach JIK; lemon juice, Sprite and Ritebrand bleach; and lime juice, sugar, Listerine mouth wash (homemade floral preservatives) were used. Tap water was used as the control. The treatments were laid out in Randomized Complete Block Design (RCBD). After 21 days, Epidendrum orchid cut flowers treated with the combination of vinegar, apple juice and JIK had the highest petal drop (9.8), wilted leaves (8.8) and wilted florets (8.8). The lowest number of dropped petals (5.7), wilted leaves (3.8) and dropped petals (4.9) were obtained from those treated with lemon juice, Sprite and Ritebrand bleach. The longest vase life (21.0 days) of orchids was obtained from the treatment combinations of lemon juice, Sprite and Ritebrand bleach; and lime, sugar and Listerine. There was no significant ($P < 0.05$) difference in number of dropped petals, wilted leaves and wilted florets of orchids cut flowers treated with lemon, Sprite and Ritebrand bleach and those treated with a combination of lime, sugar and Listerine. Homemade floral preservative combinations of Lemon, Sprite and Ritebrand bleach and lime, sugar and Listerine could, therefore be recommended for pre-treatment of Epidendrum orchid cut flowers for best results.

Key words: Cut flowers · Floral preservatives · Orchids · Vase life

INTRODUCTION

Epidendrum orchids belong to Orchidaceae, commonly referred to as the orchid family, although their area of origin is not clear but are believed to be native to South American mainly in the tropics [1]. Orchid is one of the most preferred wedding flowers especially for the bride's and bridesmaids' bouquets; church and reception venue decorations; boutonnieres for the groom, best man and groomsmen; corsages for principal sponsors and guests; and table centrepieces. Orchids are also the favourite flower for corsages usually used by girls in proms [1].

The post-harvest longevity of cut flowers is of critical importance in determining the value of the crop. This is particularly true with cut flowers given the global nature of the flower industry and the necessity for lengthy handling and transportation times. Many investigations on the longevity and quality of cut flowers have been conducted by adding various preservatives to the vase water [2, 3], resulting in cut flowers senescence being delayed considerably. In cut flowers, the processes of flower bud opening and colour development require substrates and energy for their satisfactory development [4, 5].

Physiological and morphological responses such as wilting or bent neck caused by bacteria, lead to a decrease in the vase life of cut rose flowers [6, 7]. The post-harvest life of cut flowers is often limited by their inability to maintain photosynthesis under the lighting conditions of the interior environment where they are held, so it is important to ensure high carbohydrate levels in plants at harvest time [8]. This can be achieved by growing plant under optimum light conditions.

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The short vase life of many cut flowers continues to pose a challenge to the florist industry in general. Flowers are extremely perishable; maintaining their physiological functions very actively even after harvest and the beginning of their senescence very often depends on ethylene action [3, 9]. Other important factor in the deterioration of cut flowers involves the diminishing of respiratory substrates. The speed of these changes depends at least in part, on the amount of reserves that are present in the flower at harvesting [10]. Carbohydrates are important reserve compounds. Furthermore, a decrease of macromolecular component such as starch occurs through the course of the petal senescence. The senescence of cut flowers is closely related to a considerable reduction of the energy needed for metabolic reactions [3]. An exogenous carbohydrate supplementation would be enough to delay the senescence [11].

Many floral preservative contain germicides, ethylene synthesis inhibitors, growth regulators, some mineral compounds and carbohydrates that are essential to extend the vase life of cut flowers [11, 12]. Homemade floral preservatives containing sugar, household chlorine-containing bleach, lemon and lime juices have been widely used to prolong vase life of cut flowers [13, 14]. Chlorine-containing chemical or solution is the most common bactericides and competes with ethylene for the same site of action [15]. Sodium hypochloride (NaOCl) is markedly effective in extending the vase life of many cut flowers including carnation (*Dianthus caryophyllus* L.), Delphinium (*D. elatum* L.) [16, 17], sweet pea (*Lathyrus odoratus* L.) [16], tuberose (*Polianthes tuberosa*) [18] and Dendrobium orchids [16]. Gibberelic acid (GA_3) has been reported to delay leaf yellowing and flower shedding in Alstroemeria (*A. ligtu* L.) [19] and daffodil (*Narcissus bulbocodium* L.) [16].

Cut flowers are living, actively metabolizing, heterogeneous organs composed of floral and foliar parts each of which may be at different physiological and developmental stage. The termination of vase life of many cut flowers is characterized by wilting even though they are constantly held in water [20]. The point of termination of vase life varies from the first sign of wilting and fading [12] to the total death of all flowers [21] with all the intermediate values between these points.

Lee *et al.* [22] opined that the term vase life should represent the potential useful longevity of the flowers at the final consumer's home. The short vase life of roses is often related to water stress characterized by incomplete bud opening, rapid loss of fresh weight and water deficit and poor maintenance of turgidity. The importance of water, sugar and various other chemical preservatives to promote the keeping quality of cut flowers has been reported by several workers [23, 24].

Cut flowers are graded according to the length of their stem. The longer stem cut flowers have longer vase life, which may be due to higher carbohydrate reserve when compared to the shorter stem which enables the maintenance of dry matter and respirable substrates, especially in the petals which helps in extending keeping quality [25]. Han [23] reported that the translocation of sugars from stem accumulates in the flower, which increases the water uptake and helps to maintain turgidity in the stem thus, extending the vase life of the flowers. The stem possesses high sucrose inversion capacity, which helps to prolong the shelf-life [18]. Jordi *et al*. [26] reported that 40 cm length of cut rose stems Cv. 'Sonia' had longer vase life and higher consumers acceptance. Long stem length is accompanied by increased flower diameter and water uptake, enhancing the shelf-life of rose cut flowers [25].

Neck drop (bent neck) of cut rose flower is caused by inadequate water transport through the neck tissue and tends to be varietal characteristics. Hence, the water is an important component of cut flowers and loss of water without replenishment causes the flower to wilt and drop. However, one cannot exclude the possibility that the anti-senescence factor is water and the degradative changes in cut flower are results of water imbalance, an early symptom of senescence in cut flower is loss in fresh weight. Waithaka *et al*. [27] reported that the turgidity in plants and flowers is dependent on the rate of absorption and rate of water loss. Increase in fresh weight can occur when the rate of water absorption is more than the rate of transpiration. Waithaka *et al*. [27] also reported that the composition of 'tap water' varies greatly in various locations. This may influence the longevity of the flowers kept in tap water, as well as the efficiency of chemical solutions used for holding, pulsing or bud opening. In cut flowers, the loss of water from all tissues depends on the environmental factors and immediately after cutting of the flower, a sharp decrease in water loss occurs due to closure of stomata [6].

Organic acids play an important role in reducing the pH in preservative formulations. Generally, citric acid is used to lower the pH of vase solutions for gladiolus (*G. glandiflorus* L.) [24]. A pre-shipment treatment with citric acid (150 PPM) added to the pulse solution was found to be effective in carnations. Citric acid prevents the plugging of vascular bundles improved the water balance and enhanced the intensity of petal colour probable by changing the pH of cell sap. Use of citric acid at 0.5-0.7% in holding solution promoted the floral development and keeping quality of cut spikes of tuberose [6].

In roses, the loss of petal turgidity and fresh weight was preceded by a decreased rate of water uptake, indicating that reduced uptake rather than excessive water loss is responsible [27]. Since water tension in the flaccid flower is not transmitted to the base of stem a "stem blockage" was suggested within the xylem vessels [27]. The reduction in stem conductivity is caused by several factors. Microbial growth paralleled the increase in stem resistance to water flow. Therefore, micro-organisms were considered to be one of the main causes of reduced water uptake in cut flowers.

Use of aluminium sulphate ($Al_2(SO_4)_3$) as a germicide in floral preservation is recommended [6]. They reported that the colour, form and longevity were more in $Al_2(SO_4)_3$ treated flowers. Aluminium sulphate (50-100 ppm) has been used in many preservative formulations of roses and other flowers. Waithaka *et al*. [27] attributed the effect of aluminium to lowering the pH of rose petals and stabilizing the anthocyanins, thereby improving the keeping quality of rose cut flowers. All preservative formulations include at least one compound with germicidal activity.

Silver (Ag^+) is the most common and active mineral ion, which acts as a germicide [26]. Silver nitrate and silver acetate (10-50 PPM) are the two most effective bactericides used in preservative formulations. Han [23] reported that more solution uptake was found in flowers kept in $Al_2(SO_4)_3$. Variation in solution uptake may be due to disturbance in transpiration pool; and bacterial and fungal species gaining predominance in vase solution. Aluminium sulphate enhances solution uptake by acting as anti-bacterial agent. Silver inhibits the 1-Amino cyclo propane-1 carboxylic acid (ACC) content and the rise in respiration in carnation flowers [24]. Since silver nitrate is relatively immobile in stems of flowers, it increases cut flower longevity only by reducing bacterial contamination or to some extent by acting as an anti-ethylene action agent in wound on the cut stem surface. Shanon [28] reported that natural plant essential oils found in lavender (*Lavendula angustifolia* Mill.), geranium (*Perlagonium graveolens* L.), anise (*Pimpinella anisum* L.) and cumin (*Cuminium cyminum* L.) significantly prolonged the vase life of rose cut flowers. Essential oils are safe and environmental friendly substances with anti-microbial properties.

Silver reduces ethylene-binding capacity and suppresses endogenous ethylene production [7, 11] thereby delaying the appearance of characteristics such as premature wilting, petal in-rolling and abscission of flowers and buds [3, 29]. In many plant tissues, ethylene treatment results in rapid loss of chlorophyll in leaves and unripe fruits. In plant tissues, ethylene commonly stimulates senescence, loss of protein and susceptibility to desiccation and decay.

The plant hormone, ethylene, is responsible for early senescence in many flowers such as orchids, roses etc. [6]. Vase life of cut flowers can be improved by delaying senescence using ethylene synthesis and receptor inhibitors such silver thiosulphate (STS) complex [11]. The use of preservative solutions is considered a common practice for the storage of floral stems. These treatments control ethylene synthesis, retard pathogen development, maintain plant water and respiration balance, contribute to colour conservation, floral bud development and opening [3, 12, 15, 30].

The main aim of this investigation was to determine the effects of commercial floral preservative and locally available preservatives materials (sugar, lime, vinegar, apple juice, laundry bleach, antiseptic mouth wash and soft drinks) on the vase life of orchids. The vase life of many cut flowers including orchids is generally not satisfactory to consumers. Several attempts to prolong the vase life has been made using commercial floral preservatives like Florissant, Chrysal, Floralife, Bloomlife, Petallife, Roselife, Everbloom, etc. These preservatives may be costly and out of reach for most small scale cut flower growers, hence the need for evaluating locally available floral preservatives which would be cheaper and induce the same or even better effectiveness as the commercial ones.

MATERIALS AND METHODS

Experimental Site: The experiment was conducted in Biology Laboratory, Crop Production Department, Faculty of Agriculture, Luyengo Campus at the University of Swaziland. Luyengo area is positioned between latitudes 26° N and 41° S and longitudes 31°W and 12°E. It is situated at around 760 m above sea level.

Table 1: Treatment applied in the experiment

Treatments	Type of floral preservatives/litre
1	Chrysal (45 g)
2	30 ml vinegar, 45 ml apple juice and 15 ml JIK [Reckitt Benckiser (PTY) Ltd, Republic of South Africa (RSA)]
3	35 ml lemon juice, 45 ml Sprite (Coca-Cola Co.) and 15 ml Ritebrand bleach [Shoprite Checkers (PTY), RSA]
4	30 ml lime juice, 10 g sugar and 20 ml Listerine antiseptic mouthwash [Johnson and Johnson (PTY) RSA] 5 Tap water (control)

Plant Materials: Cut flowers of Epidendrum orchids (*Epidendrum radicans* L.) were obtained from Vickery Seedling Company in Malkerns, Swaziland. The cut flowers were selected at commercial maturity when lower florets (6 florets) of the spike were opened. Flower stems were 70 cm long and leaves on the lower section of the stem were removed.

Experimental Design: The treatments were as described in Table 1. The treatments were laid out in a randomized complete block design (RCBD). Each treatment was replicated four times and seven cut flower stems were used for each replication. Cut flowers were pulsed in the different solutions for 12 hours. The control stems were treated with tap water. The treated cut flowers were, thereafter, placed in 1,000 ml-conical flasks containing tap water, which was replaced every two days.

Data Collection: Observations were recorded on floret wilting, wilting of leaves, petal drop and shelf-life.

Data Analysis: Data collected was subjected to analysis of variance (ANOVA) using MSTAT-C at $P = 0.05$. Means that were significant were separated using Duncan New Multiple Range Test (DNMRT) at 5% level of significance.

RESULTS

Floret Wilting: There was a significant ($P < 0.05$) difference in the floret wilting of Epidendrum orchids among the different floral preservatives in all determination stages (6, 11, 16 and 21 days after treatment) (Table 2). Floret wilting increased with increased duration of cut flowers in the vases. At 21 days after treatment, the lowest number of wilted florets (4.9) was observed in orchid cut flowers treated with a combination of lime, sugar and Listerine (Table 2). However, the highest number of wilted florets (8.8) was observed in cut flowers treated with vinegar, apple juice and JIK. The number of wilted florets in orchids treated with vinegar, apple and JIK was almost double that obtained from cut flowers treated with lime juice, sugar and Listerine. The orchid cut flowers treated with commercial floral preservative, Chrysal, had a significantly ($P < 0.05$) higher number of wilted florets as compared to those treated with lime juice, sugar and Listerine (Table 2).

Foliage Wilting: There was a significant ($P < 0.05$) difference in the wilting of leaves among the orchid cut flowers treated with the different floral preservatives at 11, 16 and 21 days after treatment (Table 3). Leaf wilting increased with increased duration of cut flowers in the vases. At 21 days after treatment, the lowest number of wilted leaves (3.8) was obtained from Epidendrum orchid cut flowers treated with combination of lemon juice, Sprite and Ritebrand bleach (Table 3) However, the highest number of wilted leaves (8.8) was observed in cut flowers treated with a combination of vinegar, apple and JIK. The number of wilted leaves in cut flowers treated with vinegar, apple and JIK was more than double that observed in cut flowers treated with lemon juice, Sprite and Ritebrand bleach (Table 3). The number of wilted leaves in cut flowers treated with commercial floral preservative, Chrysal was significantly higher than in those treated with lemon juice, Sprite and Ritebrand bleach (Table 3).

Petal Drop: There was a significant ($P < 0.05$) difference in the petal drop among the orchid cut flowers treated with the different floral preservatives at all stages of determination (6, 11, 16 and 21 days after treatment) (Table 4). At 21 days after treatment, orchid cut flowers treated with a combination of lemon, Sprite and Ritebrand bleach had the lowest number of dropped petals (5.7). However, there was no significant ($P < 0.05$) difference in number of dropped petals between cut flowers treated with a combination of lime, sugar and Listerine and Chrysal (Table 4). The highest number of dropped petals (9.8) was observed in cut flowers treated with a combination of vinegar, apple juice and JIK (Table 4). The number of dropped petals in cut flowers treated with lemon, Sprite and Ritebrand bleach was almost double with that observed in cut flowers treated with vinegar, apple juice and JIK (Table 4).

Table 2: Effects of floral preservatives on wilting of florets in orchids

	Number of wilted florets/number of days after treatment			
Treatment	6	11	16	21
Tap water	2.8a	4.3a	5.2a	7.0b
Vinegar, apple juice and JIK	1.9b	3.9a	5.2a	8.8a
Chrysal	1.7b	3.4b	4.3b	5.7b
Lime, sugar and Listerine	1.6b	2.5c	3.7b	5.0c
Lemon juice, Sprite and Ritebrand bleach	1.5c	3.3b	3.9b	4.9c

Means followed by same letter along columns not significantly different. Mean separation by DNMRT at $P < 0.05$.

Table 3: Effects of floral preservatives on wilting of leaves in orchids

	Number of wilted florets/number of days after treatment			
Treatment	6	11	16	21
Tap water	1.0a	2.5a	3.9b	6.7b
Vinegar, apple juice and JIK	1.0a	2.2b	5.6a	8.8a
Chrysal	1.0a	2.1b	3.6b	5.3c
Lime, sugar and Listerine	1.0a	1.4c	3.4b	4.1d
Lemon juice, Sprite and Ritebrand bleach	1.0a	1.6c	3.3b	3.8d

Means followed by same letter along columns not significantly different. Mean separation by DNMRT at $P < 0.05$.

Table 4: Effects of floral preservatives on petal drop in orchids

	Number of wilted florets/number of days after treatment			
Treatment	6	11	16	21
Tap water	1.3a	3.0a	4.4a	7.5b
Vinegar, apple juice and JIK	1.3a	2.5a	5.0a	9.8a
Chrysal	1.0b	2.3b	4.2a	6.5c
Lime, sugar and Listerine	1.0b	2.0b	3.4b	6.3c
Lemon juice, Sprite and Ritebrand bleach	1.0b	1.5c	3.3b	5.7c

Means followed by same letter along columns not significantly different. Mean separation by DNMRT at $P < 0.05$.

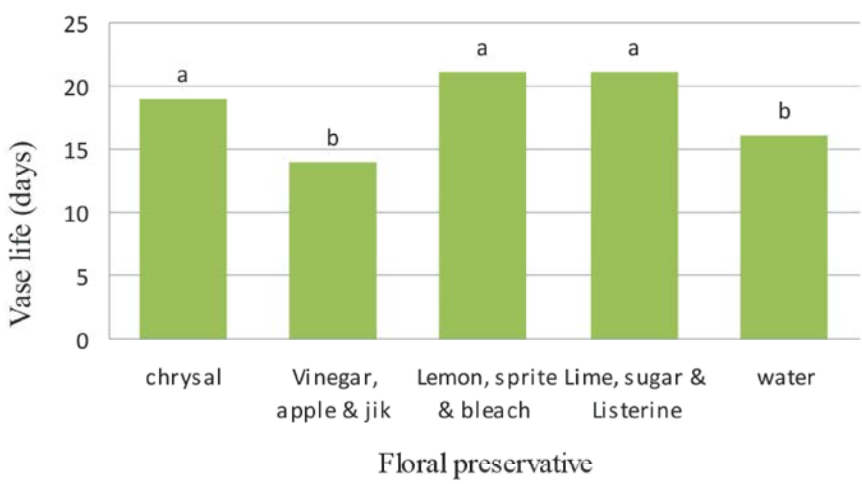

Fig. 1: Effects of floral preservatives on vase life of orchids.
Bars followed by the same latter are not significantly different. Mean separation by DNMRT at $P \leq 0.05$.

Vase Life: The longest vase life (21.0) was observed in orchids cut flowers treated with combinations of lemon, Sprite and Ritebrand bleach and those treated with lime juice, sugar and Listerine (Figure 1). The shortest vase life (13.7) was observed on flowers treated with vinegar, apple and JIK. However, there was no significant ($P < 0.05$) difference observed in the vase life of orchid cut flowers treated with Chrysal; lemon, Sprite and Ritebrand bleach; and lime juice, sugar and Listerine (Fig. 1).

DISCUSSION

Lemon juice, Sprite and Ritebrand bleach treated Epidendrum orchid cut flowers had the longest vase life and the lowest number of wilted leaves. Cut flowers treated with vinegar, apple and JIK had the poorest foliage condition and shortest vase life. Floret wilting is mainly due to depleted plant food and the inability of the plant to draw up water which leads to the subsequent colour change and flaccidity of the cell [31]. Flaccid cells give the flower a wilting appearance and this may be improved by adding an effective bactericide in the pulsing solution that will eliminate the accumulation of bacteria along the vascular bundle blocking the water path way to the petal. According to Almasi *et al*. [32], yellowing, drooping, epinasty and venation of florets in Dendrobium orchids are major signs of senescence in cut flowers. The deterioration and discolouration are due to an increase of vacuole's pH or enzyme effects such as polyphenol oxidase and peroxidase on senescing flowers [32, 33].

It was found out that, flowers which had less wilted leaves also had longest vase life when compared to those that had the more wilted leaves. Epidendrum orchid cut flowers treated with combination of lemon, Sprite and Ritebrand bleach had the lowest number of wilted leaves which could probably be attributed to sufficient carbohydrates and good water balance. Sprite was found to be the best source of sugars in this investigation.

The relationship between cut flower foliage and vase life was illustrated by Lanza [34] in his experiment with roses and carnations. It was concluded that the presence of healthy foliage enhances carbohydrates content in the stem and hence the ability to stay longer in the vase. Lanza [34] also pointed out that it is very crucial for the maintenance of the water potential between the leaf and the stem bottom. This will enhance the process of photosynthesis and also balance the extent of respiration; hence the bloom life is extended. Wilting of leaves is a direct sign of inability of the stem to absorb water and hence the manifestation of flower death. Frazer [35] also stated that, the occurrence of air embolism is also responsible for the wilting leaves.

Orchids cut flowers treated with a combination of vinegar, apple and JIK had the highest rate of petal drop, which is a sign of senescence. Senescence may induce petal drop in cut flowers and rapid opening of flowers [36]. This then causes a decline in cut flower condition. The abscission of petal may be attributed to the depletion of food reserves and injury of petal induced by chlorine ions. Hlophe [37] obtained similar results in rose cut flowers. Flower shattering occurred in the water treated cut flowers (control), which is probably attributed to lack of food in the solution, thus forcing the flower to use all its reserves. The combination of lemon, Sprite and Ritebrand bleach was the most effective floral preservative in controlling senescence and petal drop. Ketsa *et al.* [38] reported that time to wilting of Dendrobium orchids flowers was probably regulated by ethylene. They also showed that application of sugar drastically reduces sensitivity of cut flowers to ethylene.

The longest vase life of Epidendrum orchids was 21.0 days which was observed on cut flowers treated with a combination of lemon juice, Sprite and Ritebrand bleach and those treated with lime juice, sugar and Listerine. Orchid cut flowers treated with a combination of vinegar, apple and JIK had the lowest vase life and this could probably be attributed to injury of the stems by chloride ions in JIK. Cut flowers treated with this mixture showed a poor opening of the florets when compared with control. High concentration of chlorine in water can cause a detrimental effect on flower keeping quality [1]. It however, takes place after senescence of the cut flower. In general, JIK is a very useful germicide in flowers that are prone to bacteria like gypsophila.

CONCLUSIONS

The best pulse treatment for the extension of vase life of orchids was the combination of lemon, Sprite and Ritebrand bleach. Cut flowers treated with combination of vinegar, apple and JIK had the highest rate of deterioration in terms of floret wilting, wilting of foliage and dropped leaves. Homemade floral preservatives with the combination of lemon, Sprite and Ritebrand bleach; and lime, sugar and Listerine were found to be superior in this investigation in terms of reducing petal drop, floret wilting and leaf wilting in Epidendrum orchids. Small scale cut flower growers should use these two floral preservatives to improve condition and increase vase life of orchids.

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