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Evaluation of Biox 5000 (chlorine dioxide) and HTH (calcium hypochlorite) on the quality and vase life of *Rosa hybrida* L. cv. Frisco

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ABSTRACT

Prolonged vase life of a cut flower sorely depends on the post-harvest treatment and handling given to it. There are many factors both biological and man-made that result in shorter vase life and reduction of quality of rose cut stems. A laboratory experiment was carried to evaluate the potential of post-harvest treatments Biox 5000 (chlorine dioxide) and HTH (calcium hypochlorite) on the quality and potential of prolonging vase life of Frisco rose cultivars. The experiment was arranged as a 3×2 factorial laid in a completely randomised design (CRD). There were 6 treatments replicated 3 times to give 18 experimental units. The 2 factors were postharvest solution and hydration period. The postharvest solution factor had 3 levels: Biox solution, HTH solution and tap water whilst the hydration period factor had 2 levels: 2 hours and 4 hours. Numbers of fully open, half open, stems at bud stage, stems with botrytis spores and bent neck stems were recorded and evaluated. There were significant differences (P<0.05) in number of fully open stems, stems with botrytis and stem straightness. However, there were no significant differences (P>0.05) on number of half open stems and stems that remained at bud stage. It was concluded that Biox 5000 had an effect on stem straightness, disease incidence and petal openness. Recommendations of Biox 5000 at 200 ml were advised to be used as a standard post-harvest treatment to maintain quality and vase life of Frisco rose cultivar.

Keywords: Rose, Quality, Vase life, Postharvest treatments

INTRODUCTION

Roses (*Rosa hybrida* L.) are valuable cut woody perennial flowers that belong to the Rosaceae family which has been classified as the fourth largest rank of production worldwide [1]. In United States, roses' income grossed up to $23.5 million, with California being a leading state [2]. In Zimbabwe roses are grown for export, the main market being Europe particularly Holland [3]. As cut flowers, roses have short vase life that relates to ethylene production as it causes wilting, bent necks and vascular blockage by air embolism and microorganisms proliferation [4]. Vase life is defined as the time taken by a cut stem or foliage to retain its appearance in a vase [5]. Roses have certain economic importance as they are used as ornamental plants, in perfume making industries, food and drink industries, and also can be used to make medicine and in art industry [6].

Vase life is one of the most important characteristics determining the commercial value of ornamental plants [7]. Vase life is vital in cut flower production as it determines the market price of many flowers [8]. The vase life of roses is affected by numerous factors such as cell programmed death, senescence, dehydration or loss of assimilates and substrates [9]. Water relation and balance plays the main role in postharvest quality and endurance of cut flowers and water relation disturbance at some point in time is principally the reason of short vase life for cut flowers [10]. Bleeksma and van Doorn [11] stated that water relation interruption is typically due to microorganism proliferation in vase solution and clogging up in the basal end of the cut flower stem by microbes.

Apart from vessel blockage, bacteria discharges pectinases and other lethal compounds and ethylene manufactured speeds up senescence [12]. It has also been found out that besides vase life being reduced, interruption of water relation in rose cut stems causes some physiological disorders such as bent necks, lack of flower opening, and wilting of the leaves accompanied by improper petal openness. The control and reduction of microbial proliferation is a precondition for prolonging quality and permanency of cut flowers, particularly for cut stems. On the other hand applied biocides could also severally or predominantly disturb other physiological functions of cut stems mainly their photosynthetic tissues, function and membrane permeability because of their noxious compounds excreted during postharvest expansion and aging [13].

The use of post-harvest treatments such as silver nitrate, silver thiosulfate, and hydroxyl quinoline and ethanol avoids vascular blockage and ethylene action [14]. However, some of these compounds such as silver nitrate and silver thiosulphate have been reported to have displayed ecological risks and health hazards while other post-harvest solutions such as hydroxyl quinoline have shown plant phyto-toxemic effects [15]. In the cut stem market there is a vital need for maintaining treatments that control microbial pollution effectively and beside that do not show environmental risks and phytotoxicity [10]. This need is vital in enhancing the quality and vase life of roses so as to satisfy the needs of the end users. Usually the market requires disease free plants and also pest free plants with no cut worms, botrytis, powdery mildew, downy mildew, crown gall and also stems with upright straightness. To achieve the above standards vase life has to be prolonged to some extent by elimination of microbes soon after harvest and this is achieved by use of effective post-harvest treatments. Therefore, there is to evaluate the effectiveness of Biox 5000 and calcium hypochlorite (HTT) as alternatives vital in enhancing the quality and vase life of roses so as to satisfy the needs of the end users.

It therefore becomes imperative to evaluate the potential of Biox 5000 (chlorine dioxide) and HTH (calcium hypochlorite) post-harvest treatments on quality and vase life of rose cut flowers.

MATERIALS AND METHODS

Study site
The study was conducted at Southern roses, situated 16 km east of Harare, Zimbabwe. The area is located at a latitude of 31º08' E and 17º55' S and an altitude of 1479 m above sea level. The area falls under Natural Farming Region II of Zimbabwe's Agroecological zones, with an average temperature of 25°C.

Experimental design and treatments
The experiment was arranged as a 3×2 factorial laid in a completely randomised design (CRD). There were 6 treatments replicated 3 times to give 18 experimental units. The experiment had 2 factors which were postharvest solution and hydration period. The postharvest solution factor had 3 levels: Biox solution, HTH solution and tap water whilst the hydration period factor had 2 levels: 2 hours and 4 hours.

Experimental procedure
Three containers were prepared containing three different solutions:viz: HTH, Biox 5000 and tap water. One hundred and eighty stems of Frisco rose variety were harvested using secateurs at bud stage and pinhole visibility, 2’5 position as required by the market Dutch Auctions. Sixty stems were allocated in each bucket separately. Flowers were moved to the hydration room after harvest for two hours and four hours hydration time with less than 12ºC temperature conditions to remove field heat, stress and waiting to be graded. Two hours later of hydration, 30 upright stems were selected from each bucket, stripped for the bottom four leaves, bunched and labeled separately HTH (2 hours), Biox 5000 (2 hours) and Tap water (2 hours) and they were packed in a box with cotton to prevent mechanical damage. The box was left in a cold room under 3ºC for 48 hours. For the remaining stems in the bucket, hydration time was increased for 2 hours to make it 4 hours. After 4 hours, the same procedure was carried out as for the first flowers but this time they were labeled 4 hours.

Vase life layout in the laboratory
After 48 hours of flowers being in the cold room, 18 vases were laid in a laboratory to assess vase life and ten stems were allocated in each stem. The vases were treated with 20 ppm chlorine to disinfect diseases and 1 litre of borehole water was put in each vase. A pulsing treatment, Rose food (Rosa big™) was added in the vases with stems to prolong vase life. Ten stems were allocated in each vase as treatments and labeled separately as 2 hours and

4 hours according to the way they were hydrated. The experiment was monitored daily and data collection was done after seven days.

Data collection and analysis

Numbers of fully open rose cut stems, half open stems, stems with botrytis, bent necks and half open stems that remained at bud stage, were taken on daily basis. The data was analysed using GenStat statistical package, 14th Edition. Least significant difference (LSD) was used to separate means at 5% significance level.

RESULTS AND DISCUSSION

Petal openness

There was significant difference (P<0.05) in the number of fully open stems recorded through evaluating the potential of HTH, Biox 5000 and tap water post-harvest solution. After 7 days of vase life and stem quality assessment Biox 5000 scored the highest number of stems that were fully open followed by HTH and tap water that scored the least number of stems that were fully open (Fig. 1). Flowers in the 2 hours hydration period had higher mean number of fully open cut stems than those in the 4 hours hydration period (Fig. 1). Generally post-harvest treatments and hydration time showed a significant interaction (P<0.001).

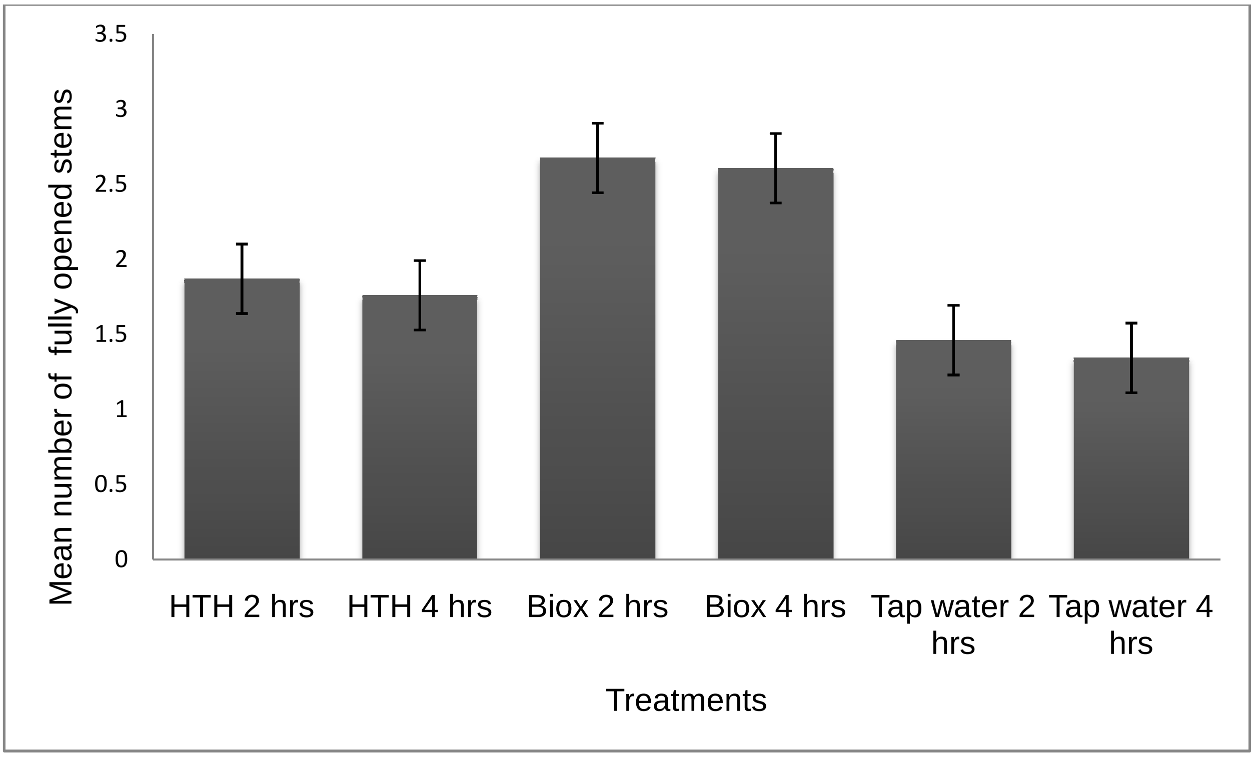

Fig. 1: Effects of postharvest solution and hydration time on fully open rose cut stems

Generally, the findings are similar to Bahrehmand *et al.* [16] who observed that flower opening was highest in stems under chemical postharvest treatments compared to the control. Biox treatment at 2 hours performed better because it is more stabilized chlorine and its active ingredient does not dissociate faster [17]. On the other hand, HTH which is calcium hypochlorite dissociates faster especially after 2 hours [18]. This is why it recorded a lower number of fully open stems at 4 hours hydration time (Fig. 1). Tap water recorded the least stems that were fully open. This can be attributed to lack of aluminum sulphate and a wetting agent in tap water which might have increased microbial proliferation resulting in bacterial plugging of cut flower stems reducing its efficacy as a post-harvest treatment. The least stems that were fully open may be linked to bacterial plugging and air embolism formed especially by salt water. This also applies to half open stems that were recorded in this experiment even though there were no significant differences on number of half open stems as illustrated (Table 1). The results are similar to a report by Mayers *et al.* [19] that cut flowers species had the ability to maintain their freshness after pulsing with postharvest treatment compared to untreated controls.

There was no significant difference (P > 0.05) in stems that attained half open bloom among the 3 postharvest treatment solutions. However, HTH scored the highest number of stems that were half open followed by tap water while Biox scored the least. There was also no significant interaction (P>0.5) between post-harvest solution and hydration time in the treatment means (Table 1). On half open stems these results obtained may be linked to undesirable temperatures received by stems resulting to half open stems. Cut stems are usually harvested at bud stage so as to reduce desiccation, susceptibility to mechanical damage and also increasing packing density. Moreover, Hussen and Yassin [20] reported that cut flowers can be greatly affected by the chemical composition of the vase solution. Failure of the stems to bloom can also be attributed to genetic traits of that flower.

Table 1: Effect of postharvest treatment and hydration time on number of half open stems, number of stems at bud stage and number of stems with botrytis spores

Treatments	Half open	Bud stage	Botrytis
HTH 2 hrs	1.171^{a}	1.052^{a}	1.744^{b}
HTH 4 hrs	1.052^{a}	1.344^{a}	1.744^{b}
Biox 2 hrs	1.344^{a}	1.052^{a}	0.88^{a}
Biox 4 hrs	1.462^{a}	1.255^{a}	0.88^{a}
Tap water 2 hrs	1.344^{a}	1.44^{a}	1.642^{b}
Tap water 4 hrs	1.344^{a}	1.052^{a}	2.121^{b}
Grand mean	1.286	1.914	1.512
Fprob	0.584	0.863	<0.001
CV %	21.3	22.9	17.9
L.S.D	0.4882	0.4869	0.4809

Means followed by same superscript letter were not significantly different at P<0.05.

There was no significant difference (P>0.05) in stems that remained at bud stage among the treatments, with Biox 5000 scoring the highest number of stems that remained at bud stage followed by HTH and tap water which recorded the least number of stems that remained at bud stage (Table 1). There was also no significant interactions (P>0.05) between the two factors (hydration time and post-harvest solution). All treatments showed no significant differences on flowers remaining at bud stage and this can be attributed to the fact that stems might not have been harvested at the correct cut stage even though literature states that roses are harvested at bud stage.

On petal openness, Biox 5000 generally performed better than other treatments. This can be attributed to the presence of a wetting agent sanawett which was added when the Biox solution treatment was prepared. This concurs with Baird and Zublena [21] who reported that a wetting agent reduces surface tension; this therefore increases water uptake through the stem. This also agrees with Reid [22] who reported that a wetting agent reduces water deficit in stems and leaves thereby contributing to a longer vase life of cut roses. Wetting agents promote water uptake in cut stems during dry transport by reducing surface tension of water [23].

Botrytis sporulation

There was significant interaction (P<0.001) between hydration time and post-harvest treatment among the treatments in the mean number of stems with botrytis spores among the treatments. Tap water (most susceptible) at both hydration times exhibited the highest disease incidence percentage (number of stems with botrytis spores) followed by HTH (least susceptible) while with Biox 5000 (most resistant) scored the lowest percentage of stems with diseased stems (Table 1). Tap water at 4 hours hydration time was the most susceptible treatment in the experiment as it recorded the highest number of stems with botrytis followed by HTH. These results are similar to what was reported by Hatami *et al*. [24] who observed highest bacterial counts on the control treatment, distilled water. This can be due to the fact that longer hydration periods in water promote humid conditions which highly favour germination of botrytis spores (Bissett, 2002). This is in agreement with OMAFRA [25] who reported that if cut stems are left inside water solutions, botrytis spores grow rapidly since wet conditions favour and activate germination of spores. Moreover, this could be due to the fact that since they are no chemical components to eliminate these spores in tap water, many botrytis spores grew. Botrytis spores observed in cut stems treated with HTH can be attributed to the fact that HTH dissociates faster [18] hence encourages fungal sporulation..

Stem straightness

There was also significant interaction (P<0.05) between hydration time and post-harvest treatment among the treatments in the stem straightness in terms of the number of stems with bent necks .Tap water at 4 hours hydration time scored the highest number of stems with bent necks followed by HTH at both hydration times and lastly Biox 5000.which recorded the least number of stems with bent necks (Fig. 2).

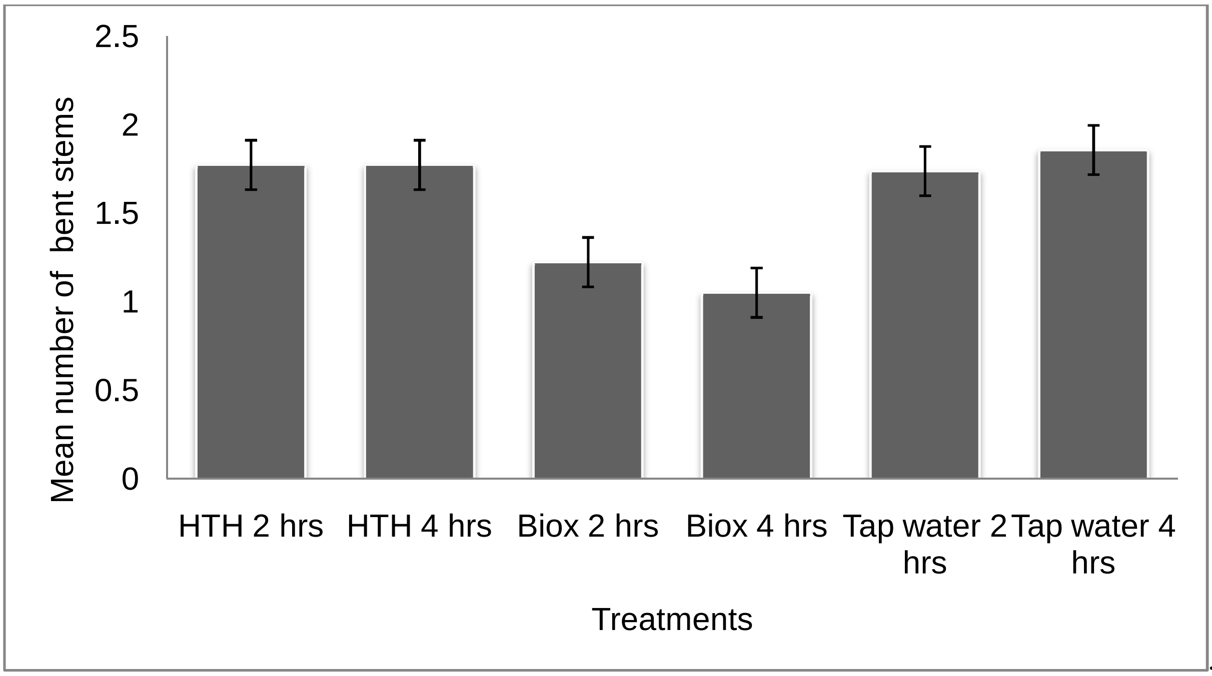

Fig. 2: Effects of postharvest solution and hydration time on stem straightness

Tap water had the highest number of stems with bent necks (Fig. 2). This can be attributed to the fact that tap water lacks chemical treatment hence is most likely to have been contaminated by microorganisms. Mclntosh [26] reported that bent necks are physiological disorders of cut stems caused by air emboli, bacterial plugging and subsequent poor water flow into the bloom. Whether pumped from a home well, tap water can contain a range of contaminants that harm plants. Moreover, tap water with excess salts can prevent roots from absorbing enough water and nutrients [27] and salt water negatively affects plants by dehydrating them resulting in bent necks. Ramsey [28] also reported that tap water treated with chlorine and fluorine may cause undesirable effects if used in larger amounts. However water flow has also been attributed to blockage caused by particulates clogging the xylem [22,29].

Bent necks in tap water can also be attributed to be caused by vascular occlusion, which inhibits water supply to the flowers [22]. The observed cloudiness in the vase solution could have been due to precipitation of particulates that occluded stems and led to the development of bent necks. Addition of a wetting agent which reduces surface tension of water increased uptake through the stem and this wetting agent was lacking in HTH and tap water but was available in Biox 5000. Reduced water uptake has been shown to decrease vase life when there are no carbohydrates in the vase water. It has also been reported that embolisms are thought to be mostly bacterial in nature such that the addition of compounds with antibacterial effects greatly reduces the occurrence of bent necks [22,29,30].

CONCLUSION

The results of the present study showed that Biox 5000 promoted petal openness, reduced disease incidence in terms of number of stems with Botrytis spores and resulted in maintenance of good stem straightness as it reduced the number of bent stems. Biox 5000 thus improved quality of the stem and showed potential of prolonging vase life to more than 10 days. This solution can therefore be used by rose producers for postharvest treatment of the flowers in order to improve quality and vase life. However, HTH is also a superb alternative for postharvest treatment of flowers where Biox 5000 is not available. Tap water reduced rose stem quality and subsequently shelf life hence cannot be used for postharvest treatment.

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