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Postharvest Performance of Selected Cut Flower and Foliage Species Sold in the Retail Market of Sri Lanka

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ABSTRACT

The vase life evaluation studies on cut ornamentals are generally performed on freshly harvested produce. In Sri Lanka, no study has been done to assess the longevity at consumer sites of the cut flower and foliage species sold by retailers. Therefore, experiments were conducted using cut roses, gerbera, alstroemeria, ox eye daisy and kithul to evaluate their performance at consumer level. Flowers and foliage were obtained from a sample of eight sellers in the North Western Province of Sri Lanka. A factorial experiment in completely randomized block design with five replicates and five species was conducted. All species displayed symptoms of senescence ≤ 5 days of purchase from the retailers. The rate of water uptake by the cut stems gradually declined over the vase period in all species. Although there were differences among sellers, there was a general tendency to decline the relative fresh weight of stems over time in all the species. Further research is needed to develop effective and affordable treatments, such as holding solutions and vase solutions, to extend the longevity of cut flowers and foliage sold at retail sites.

KEYWORDS: Cut flowers, Cut foliage, Postharvest senescence, Retail market, Vase life

INTRODUCTION

Floriculture has become a profitable sub-sector of agribusiness in Sri Lanka. The climatic variation coupled with a diverse terrain enables Sri Lanka to develop a wide range of floriculture items. The industry has grown substantially during the last few years to become one of Sri Lanka's major foreign exchange generating ventures (Dhanasekara, 1998). Export earnings from floriculture have increased from US $ 11.24 Mn in 2006 to US $ 11.74 Mn in 2010. Growth in Sri Lankan exports from 2006 to 2010 was 3% (Anon, 2011a). The total land area under floriculture is around 500 ha at present and the majority of lands are in the Western Province. Correspondingly, foliage ornamentals are grown in 472 ha which is 94% of the total land area under floriculture (Kumara *et al.*, 2007).

Cut flowers grown in the country can be divided into two main categories based on their climatic requirements; *viz.* temperate cut flowers and tropical cut flowers. Temperate cut flowers include carnation (*Dianthus* spp.), roses (*Rosa* spp.), statice (*Limonium* spp.), *Gypsophila* spp., *Alstroemeria* spp., *Gerbera* spp., lilies (*Lilium* spp.), and *Iris* spp. Among them, carnation and roses are grown mainly for export, in the highlands of the Central Province of Sri Lanka. *Anthurium* spp. and orchids (*Dendrobium* spp.) are the most popular tropical cut flowers which are being grown commercially for exports as well as for the local market (Dhanasekara, 1998).

Sri Lanka's floriculture industry consists of three categories of producers: a) large commercial ventures for export; b) middle level growers catering to the local market; and, c) village level producers who may sell their products to either of the two categories mentioned above (Anon, 2011b).

As flowers are actively metabolizing plant parts, they undergo ageing processes. There are many factors affecting vase life of cut flowers such as temperature, relative humidity, ethylene, light, maturity stage of cut flower, and cleanliness of the vase solution (Prasad and Kumar, 2003). In the ageing process, ethylene is found to be the main factor affecting on the freshness of the cut flowers.

The process of senescence is an important developmental program in plants. To the cut flower industry, the ability to retard flower senescence or to prolong the vase life of cut flowers is vital. Chemical solutions to extend vase life of cut flowers are experimentally formulated to disturb certain physiological processes (Rule *et al.*, 1986).

Most flower and foliage types are very sensitive to drying out. Postharvest water stress plays a major role in the cut flower longevity. Even when they are standing in water, water uptake by the cut stems decreases gradually over time (Lu *et al.*, 2010). The loss of fresh mass (*i.e.* wilting) in petals and leaves is characteristic of adverse postharvest water relations (Rule *et al.*, 1986). Problems like wilting and discoloration are common in cut flowers and foliage at florists level, particularly at hot humid destination in Sri Lanka such as Colombo, Kandy, Negombo, Chillaw and Kurunegala (Weerarathna *et al.*, 2012).

When customers receive flowers and foliage at inferior conditions, they experience a short vase life. Many vase life evaluation studies have been conducted using freshly harvested flowers and foliage. However, after various storage and handling, the longevity at consumer sites could be much shorter. In Sri Lanka, there is a serious scarcity of research on postharvest performance of cut flowers and foliage. No study has been conducted in Sri Lanka to assess the postharvest performance of cut ornamentals at the end user.

Therefore, this investigation was carried out to assess the postharvest performance of selected cut flower and foliage species sold by the retailers.

MATERIALS AND METHODS

Plant Material

Experiments were conducted at Wayamba University of Sri Lanka, Makandura, Gonawila, from January to May 2013. Cut flowers of *Alstroemeria* spp., *Gerbera* spp., ox eye daisy *(Leucanthemum vulgare)*, roses (*Rosa* spp.) and cut foliage of kithul *(Caryota urens)* were bought from eight sellers in the North Western Province of Sri Lanka. Cut flowers and foliage were selected to avoid malformations or damage related with harvesting and transport handling. They were transported to laboratory within 1 h. During transport, buckets containing stems were covered with a plastic film shroud to minimize moisture loss. Before treatment, all the leaves except the ten most upper leaves of each stems in kithul were removed and then stems of all the cut flowers and foliage were recut under water to 30 cm. They were stood into clean bottles filled with 250 ml of distilled water. Mouths of bottles were covered with Parafilm® (Pechiney Plastic Packaging, Chicago, USA). Temperature and relative humidity (RH) in the vase life evaluation environment were recorded using wet and dry bulb thermometers as 22 ± 2 °C (mean ± SD), and 58 ± 5 %, respectively.

Fresh Weight Measurements

The vases with and without flowers and foliage were weighed daily by using an electronic top loading balance. For weighing, flowers were taken out of water for as short a time as possible (20-30 s). The fresh weight (FW) of each stem was expressed relative to the initial weight. Relative fresh weight (RFW) of stems were calculated by the formula: RFW (%) = $(W_t / W_{t=0}) \times 100$; where, W_t is the weight of stem (g) at t = day 0, 1, 2, etc., and $W_{t=0}$ is the weight of same stem (g) at t = day 0 (Jowkar *et al.*, 2012).

Rate of Water Uptake

Average daily vase solution uptake was calculated by the formula: Water uptake rate (g g^{-1}FW day^{-1}) = $(S_{t-1} - S_t) / FW$; where, S_t is the weight of vase solution (g) at t = day 1, 2, 3, etc., S_{t-1} is the weight of vase solution (g) on the previous day (Jowkar *et al.*, 2012).

Determination of Vase Life

Cut stems were assessed daily for the visual appeal. The visual symptoms of deterioration given in Table 1 were considered in determining their vase life. The vase life of alstroemeria ended at ≥ 50% leaf yellowing and/or tepal abscission of ≥ 50%. Scape bending of ≥ 90° ended vase life in gerbera and ox eye daisy. In roses, ≥ 90° of neck bending and / or ≥ 50% of petal bluing and abscission were considered to terminate the vase life. In kithul, end of vase life was indicated by ≥ 50% of leaf yellowing and/or, desiccation and discolouration.

Table 1. Prominent senescence symptoms and mean number of days to appearance of first symptoms in cut flower and foliage species

Species	Prominent senescence symptoms	Days to appearance of the first symptoms(n =40)
Alstroemeria	Yellowing of leaves	2
	Tepal abscission	3
	Petal discolouration	3
Gerbera	Scape bending	5
	Petal bending	2
	Petal discolouration	3
Ox Eye Daisy	Scape bending	5
Roses	Neck bending	3
	Petal blueing	3
	Petal abscission	4
Kithul	Leaf yellowing	3
	Leaf desiccation	9
	Leaf discoloration	11

Experimental Design and Statistical Analysis

Treatments were arranged in a completely randomized block design with two factors namely sellers and species. Data on vase life, RFW and WUR were recorded each day and subjected to one-way analysis of variance (ANOVA) as nested factor factorial over time. Data analysis was accomplished using the General Linear Model (GLM) procedure of Minitab statistical package (version 15). Where there were significant differences ($P < 0.05$) between treatments, means were compared by the least significant difference (LSD) test at $P = 0.05$.

RESULTS AND DISCUSSION

Termination of vase life for many cut flowers is characterized by wilting. Wilting is generally caused by an imbalance between water uptake by the flowering stems and water loss via transpiration from their leaves and/or other organs despite their stem being held in water continuously (Halevy and Mayak, 1981; Van Doorn, 1997).

Table 2 presents the mean vase lives of different species bought from eight different sellers. The results revealed that vase life of some species had significant differences among sellers (P =0.00). The mean vase life of gerbera across the sellers was 4.9 d and there was no significant difference between sellers. High packing quality when transporting, high thickness of petals and stems may be the reasons for similarity of vase life in sellers. Vase life of alstroemeria, ox eye daisy and roses among most of the sellers was not significant except for one seller. When considering roses, the flowers in the bud stage which were sold by seller 4 failed to open during vase period. The highest vase life was observed in cut foliage stems of kithul compared to the cut flowers (Table 2). There was a variation in vase life of kithul among sellers which could have been caused by differences in freshness of foliage sold, and differences in maintaining good postharvest practices.

Table 2. Vase life of cut flowers and foliage with different sellers

Sellers	[1]Vase life (days)				
	Gerbera	Alstroemeria	Ox eye daisy	Rose	Kithul
1	6.4^{a}	5.8^{ab}	5.4^{ab}	4.6^{ab}	17.8^{ab}
2	6.2^{a}	6.0^{ab}	3.8^{ab}	5.4^{ab}	7.60^{b}
3	6.2^{a}	6.6^{a}	4.6^{ab}	6.2^{a}	5.20^{b}
4	4.2^{a}	3.4^{b}	4.0^{ab}	2.4^{b}	16.6^{ab}
5	4.0^{a}	6.4^{ab}	5.4^{ab}	3.6^{ab}	-
6	3.6^{a}	4.8^{ab}	2.8^{b}	3.2^{ab}	3.20^{b}
7	4.8^{a}	4.6^{ab}	6.6^{a}	5.4^{ab}	20.0^{ab}
8	3.6^{a}	-	3.8^{ab}	-	17.0^{ab}

[1]Values are the mean of five replicates, Values for vase life, followed by different letters within a column are significantly different from each other at $P < 0.05$ level (Tukey's test)

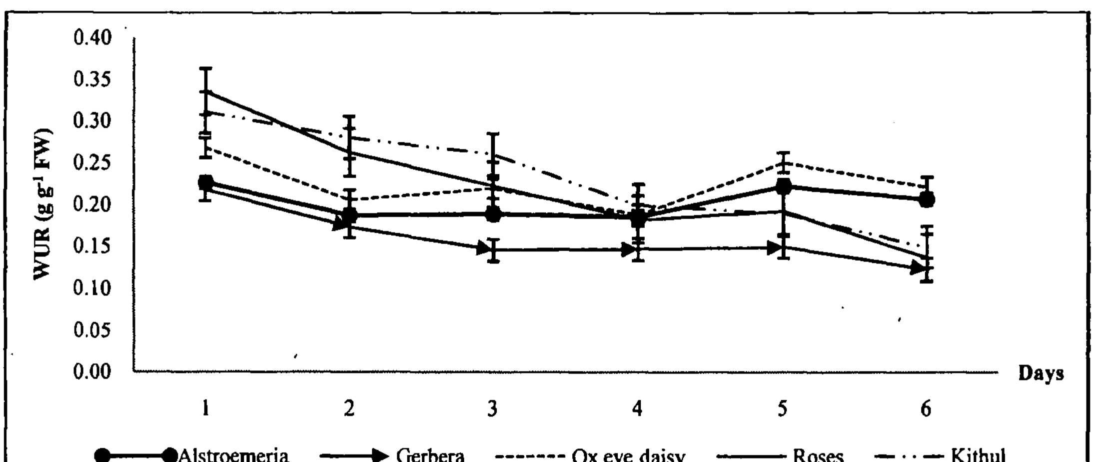

Figure 1. Water Uptake Rate (WUR) in cut flower and foliage among eight sellers
Bars indicate ± Standard Error

Table 3. Comparison of Relative Fresh Weight (RFW) in gerbera among sellers by considering probability values

Sellers	2	3	4	5	6	7	8
1	1	0.0408*	1	0.9979	1	0.9863	0.9962
2		0.2237	1	1	1	1	1
3			0.5305	0.9107	0.5118	0.9723	0.9334
4				1	1	1	1
5					1	1	1
6						1	1
7							1

* *Significant difference at P = 0.05 level*

Table 4. Comparison of Relative Fresh Weight (RFW) in ox eye daisy among sellers by considering probability values

Sellers	2	3	4	5	6	7	8
1	0.0606	1	1	1	0.9844	1	1
2		0.6515	0.1128	0.0029*	0.9896	0.006*	0.1196
3			1	0.9747	1	0.9935	1
4				1	0.9972	1	1
5					0.5496	1	1
6						0.6979	0.9977
7							1

* *Significant difference at P = 0.05 level*

Water uptake rate (P=0.003) had a significant difference among species at 95 % confidence level. Figure 1 indicates a decrease of WUR in all the species up to sixth day. In terms of the rate of water uptake, general trend was considered in all the sellers, because there were no significant differences between sellers in WUR (P=0.092).

The decrease in water uptake leads to water deficit stress and reduced turgidity in the cut flower. This also may cause the stem to bend under the weight of the flower, a phenomenon known as "bent neck" (Burdett, 1970). Water constitutes a large proportion of horticultural products weight. In addition to water, carbohydrates are the other major constituents. These products commonly take water and other materials from the mother plant, but when cut off, they rapidly move into senescence and death which is accelerated by water loss and weight reduction. This reduction is much higher under stress conditions (Mashhadian *et al.*, 2012).

Relative fresh weight (P=0.000) had significant difference among species at 95% confidence level. RFW in all the species decreased gradually (Data not presented). When considering first and third sellers in gerbera, significant difference were seen while there were no differences between other sellers (Table 3). In ox eye daisy, second seller differed from fifth and seventh sellers (Table 4). For alstroemeria, roses and kithul, there were no significant difference between sellers.

CONCLUSIONS

In the present study, the end-user vase life of some highly demanded cut flower and foliage species in the retail market was determined by observing their postharvest senescence symptoms. It was observed that many species displayed symptoms of senescence within a short period after purchase by the consumer. The decreasing fresh weight and water uptake rate could lead to shortened vase life. Future studies should focus on developing effective and affordable postharvest treatments (e.g. holding solutions and vase solutions) to extend the longevity of these species.

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