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GENOTYPES AND STORAGE DURATION EFFECTS ON THE QUALITY OF CUT FLOWER - GERBERA (*GERBERA JAMESONII* HOOK)

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SUMMARY

Studies on cut flowers have occurred, for improving their quality is the main priority. One of the top 10 cut flowers in the world, the gerbera, or Transvaal daisy (*Gerbera jamesonii* Hook), is a flowering plant. The presented study aimed to investigate the effect of genotypes, storage duration, and their interactions on the quality of cut flower - Transvaal daisy. Two cultivars of *Gerbera* (sweet smile and sweet surprise) and their four storage durations underwent examination on the various parameters of vase life and carbohydrates. The results exhibited that the cultivar 'Sweet smile' had exceptional values of the studied parameters compared with the cultivar 'Sweet surprise.' The treatment of seven days with dry-cool storage proved superior upon 14- and 21-day treatments (11.71, 11.05, and 5.94, respectively) and had the highest positive effects on vase life and flower carbohydrate content compared with the other two storage treatments. The treatment of zero days (non-stored flowers) was significantly superior to seven-day storage. The interactions of cultivars and storage durations gave the highest effect in reducing the depletion of the carbohydrates content in cultivars with zero days, increasing the flower's vase life. Therefore, the highest values recorded for the cultivar Sweet smile are zero days, followed by seven days of storage, compared with the rest of the treatments.

Keywords: Gerbera - Transvaal daisy (*Gerbera jamesonii* Hook), cut flower, storage durations, vase life, carbohydrates

Key finding: For gerbera (*Gerbera jamesonii* Hook), the highest desirable values emerged for the cultivar, Sweet smile, at zero days, followed by seven days of storage compared with other treatments. Sucrose is widely used in floral preservation, while cold storage facilitates conservation.

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INTRODUCTION

Gerbera (*Gerbera jamesonii* Hook), also known as Transvaal daisy, is a perennial Mediterranean herb belonging to the family Asteraceae. Considered a native plant of tropical Asia and Africa, the plant is mainly found in mountainous and temperate regions and grown in different landscapes as garden decorative and cut flowers. It also serves as interior decoration, flower bouquets, and dry flower crafts. The gerbera plant produces light-weight flowers 50–70 cm long. The flowers come in a wide range of colors, including

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yellow, white, red, orange, pink, maroon, crimson, and intermediate shades of these colors. The arrangements of delightful petals, slender flower stalk with attractive colors, and modest vase life make gerbera flowers rank a distinguished 4th position among the top 10 cut flowers in the international markets of flowers (Maitra *et al*., 2020; Darras, 2021). Transvaal daisy is in considerable demand in both local and abroad markets. The marketing quality of the cut flowers as a significant parameter makes the gerbera plant susceptible to some critical issues. Further, choosing suitable cultivars is a prerequisite to achieving sustainable productivity under growing conditions (Sangma *et al*., 2017). Bent neck and short vase life are often problems during postharvest. One of the highly recommended practices is adding chemical preservatives to the holding solution to extend the vase life of cut flowers. However, the holding solutions must generally comprise two contents, i.e., sugar and germicides.

Sucrose use is mostly a part in the technique of floral preservation. It works as the source of nutrients and respiratory substrate to delay protein degradation, improving the water balance of the flowers. On the other hand, germicides prevent the plugging of conducting tissues and control harmful bacteria. Therefore, prolonging the vase life of gerbera flowers needs a noble technique for both users and growers (Galati *et al*., 2021; Shatoori *et al*., 2021). Relatedly, Meman and Dabhi (2006) explained that a 250-ppm sucrose vase solution at 4% +8 – HQC with citric acid at 250 ppm enhanced the fresh weight of *Gerbera jamesonii* (cv. 'Savana Red') flowers. The said treatment combination promoted the solution uptake and improved the vase life of the flowers. It also enhanced the opening of the disc florets with a bright red color and increased freshness for a lengthier period. Amiri *et al*. (2009) also concluded that adding a combination of 30 ppm sucrose + 250 ppm $AgNO_3$ + 250 ppm citric acid enhanced water uptake, extending vase life consequently. In addition, this delayed the scape and stalk bending and wilting, prolonging the vase life of *Gerbera jamesonii*. Khenizy *et al.* (2013) result revealed that using export conditioning (storage in dry, cold conditions for 10 days) resulted in extended vase life and other growth characteristics of gerbera flowers.

Cold storage facilitates the conservation of various plant products. This technique keeps harvested flowers in crisp situations and markedly influences consumer acceptability. Thus, manipulating storage conditions constitutes a significant protocol in regulating demand and supply. Aghdam *et al.* (2019) reported that regulating flower supply in markets is promised through refrigerated storage. Flower storage in partly porous plastic bags helps prevent the moisture loss and reduces gaseous exchange. The lower temperatures in storage highly reduced ethylene-induced disorders and ethylene production rates. In turn, it enhances the constant postharvest quality of the flowers (Aziz *et al*., 2016; Gupta and Dubey, 2018). Low storage temperatures also restrict physical activities and metabolism of diseases and pests, improving the quality and reducing postharvest losses of cut flowers (Skutnik *et al.*, 2020).

Carbohydrates are essential for the growth of any plant part, providing the energy and basis for various growth processes. Many cut flowers' petals have levels of free carbohydrates. These levels are notable even when senescence signs happen (Jahnke *et al.*, 2020). Previous thoughts said that maintaining the carbohydrate pool in plant corolla is a relevant factor that delays senescence (Vehniwal and Abbey, 2019). In broad types of cut flowers, exogenous sugars can retard senescence, as senescence tightly participates in the depletion of energy needed for the synthetic reactions in cut flowers. The status of carbohydrates in cut flowers is a substantial factor affecting their postharvest life (Rabiza-Świder *et al.*, 2019).

In this context, the research objective was to evaluate the effect of cultivars (Sweet surprise and Sweet smile) associated with low-temperature storage periods and their interactions on the post-harvest quality of gerbera cut flowers.

MATERIALS AND METHODS

This research happened in 2020 at the Laboratory of Plant Physiology of the Department of Horticulture and Landscape, Tikrit University, Iraq. Flowers of the two cultivars of *Gerbera jamesonii,* i.e., Sweet surprise and Sweet smile flowers, got studied. The cultivar Sweet surprise has pink-colored flowers, while the Sweet smile cultivar has yellow-colored flowers. Producing both cultivars of cut flower species *Gerbera jamesonii* took place under greenhouse conditions. In March 2020, the examined flowers harvested in the morning proceeded with immediate analysis in the laboratory. The

collected flowers were during a commercial phase when two rows of outer petals are open on the central disk (Safa *et al.*, 2012). Pre-cooling the flowers, placed them in iced water for two hours to reduce the potential stress effect. Stem bases were recut 60 cm long underwater before treatment application. Dividing the flowers into two groups comprised of non-stored flowers placed in a 500 ml vase filled with 300 ml holding solution and 2% sucrose with 8- Hydroxyquinoline citrate (8-HQC 200 mg L^{-1}). It is the first group considered as the zero-day treatment, placed under laboratory conditions to finish the vase life period.

The other prepared group of flowers further divide to represent different period treatments. These treatments used a seal of polyethylene film (30 µm) to wrap the flowers tightly. Then packed in cardboard boxes, the stored flowers received a temperature of 1 °C and RH of 90%–95% for 7, 14, and 21 days. At the end of the storage period, with packaging materials removed, the stem bases were recut. The vase life termination (days) determination was according to the outer side rolling and visible wilting of flower petals (Safa *et al.*, 2012). The total carbohydrate percentage determination in the flowers used the method according to Witham *et al.* (1971). Using a complete randomized design (CRD) layout with three replications, the factorial arrangement included eight treatments, i.e., cultivar sweet surprise Vp, cultivar sweet smile Vy, 7-day, 14-day, 21-day storage periods, and 0-day as a control treatment. All data underwent statistical analysis according to SAS Program (1994), with means separated and compared by test in Duncan's multiple ranges at a level of probability at 5%.

RESULTS

Results illustrated that vase life increased significantly in *the Gerbera* cultivar sweet smile compared with the sweet surprise. The flowers of sweet smile lasted for a longer time in the vase (10.94 days) compared with the lowest time taken by the flowers of sweet surprise (9.6 days). The recorded highest value of flower vase life emerged in the treatment of non-stored flowers (0 days), achieving 12.38 days of vase life compared with other cold storage treatments (Figure 2). However, export conditions (dry cold storage) have exhibited a favorable effect on the vase life of the cut gerbera flowers. The treatment of 7-day cold storage gave 11.71 days of vase life, followed by 14 days of cold storage (11.05 days) compared with the other two cold storage periods (Figure 1).

Gerbera cultivars, storage periods, and their interaction revealed significant differences in vase life. The results further indicated that flowers of both gerbera cultivars under the treatment of 0-day storage lasted longer in the vase compared with the cold storage for 7, 14, and 21 days (Figure 3). However, the most effective treatment was the cultivar sweet surprise with 0-day storage (12.66), followed by the cultivar sweet smile with 0-day storage (12.1) and 7-day cold storage. The treatment of 21 days period resulted in the lowest values for vase life in the cultivar of sweet surprise (3.1 days). According to data presented in Figure 4, the carbohydrate content in the flower of the cultivar sweet smile (15.26 mg g^{-1}) was significantly higher than in the cultivar sweet surprise (15.04 mg g^{-1}).

Concerning the content of carbohydrates in floral corolla, the gerbera cultivars, storage periods, and their interaction revealed significant differences. The effects of storage durations illustrated that the content of carbohydrates decreased with a longer period of cold storage. Therefore, the storage treatments showed relevant differences in the content of carbohydrates. The 0-day storage treatment appeared with the highest content of carbohydrates (19.02 mg g^{-1}), as compared with the other storage treatments, i.e., 7, 14, and 21 days, with 17.47, 16.40, and 11.70 mg g^{-1}, respectively, content of carbohydrates (Figure 5).

Results regarding the effect of interactions between cultivars and storage periods showed a significant impact on the flower carbohydrate content. The carbohydrate content was higher in the cultivar sweet smile along with all storage periods than sweet surprise cultivar under the same conditions. In addition, the carbohydrate content was maximum in flowers under non-storage treatment than cold-storage treatments for both studied cultivars. Among all the treatments, the highest values of carbohydrate content came from the cultivar sweet smile with 0-day treatment (19.73), followed by the same cultivar with 7-day cold storage (17.83) (Figure 6).

The content of carbohydrates varied depending on the cultivars, storage period, and their interactions. The two cultivars recorded significantly different values for the number of carbohydrates when interacting with storage periods. The cultivar sweet smile gave the highest amount of carbohydrates under any

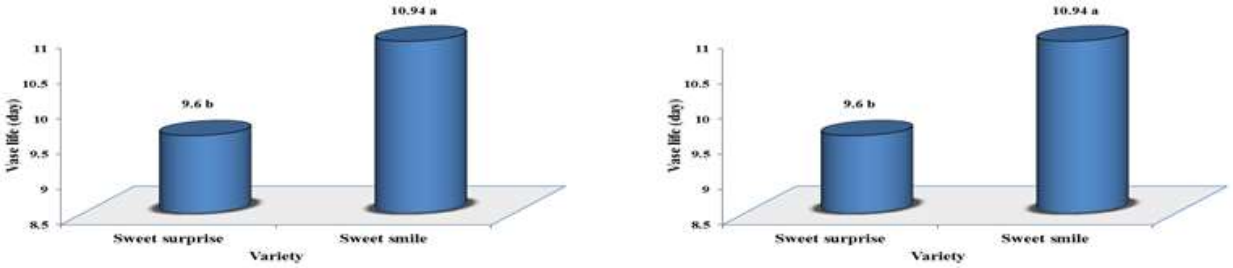

Figure 1. Effect of cultivars on vase life (days) of cut flower - *Gerbera jamesonii* Hook flowers cv. 'Sweet surprise' and 'Sweet smile.

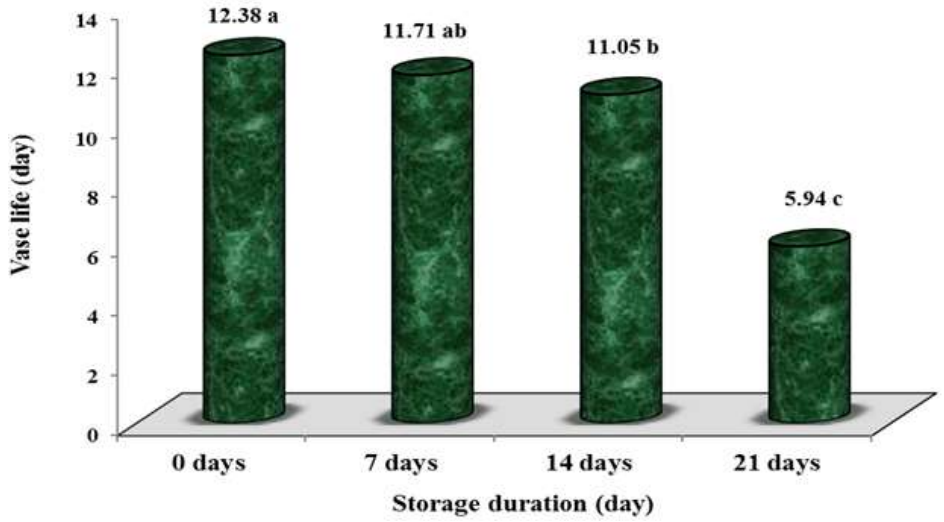

Figure 2. Effect of storage duration on vase life of a cut flower - *Gerbera jamesonii* Hook flowers cv. 'Sweet surprise' and 'Sweet smile.

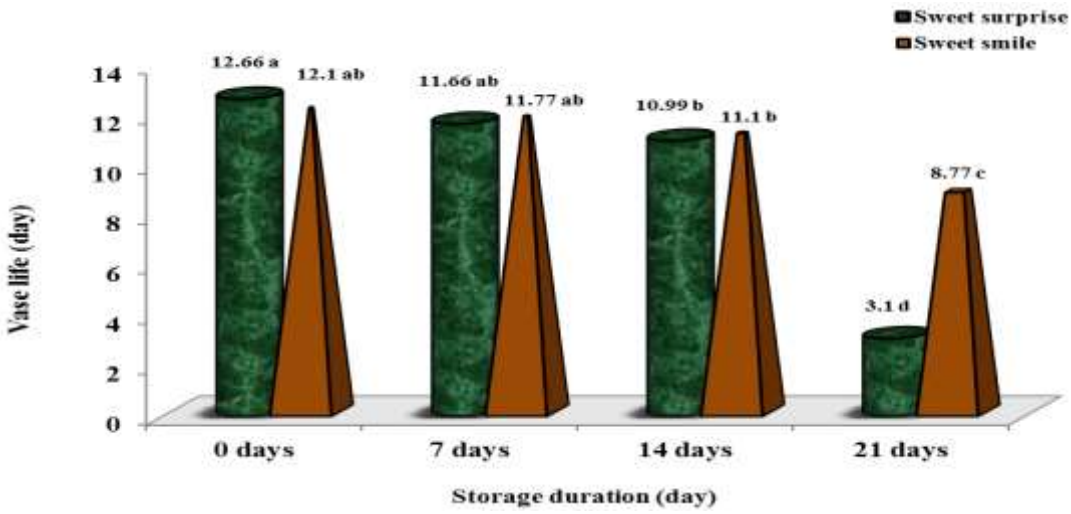

Figure 3. Interaction effect of cultivars and storage durations on vase life (days) of cut flower - *Gerbera jamesonii* Hook flowers cv. 'Sweet surprise' and 'Sweet smile.'

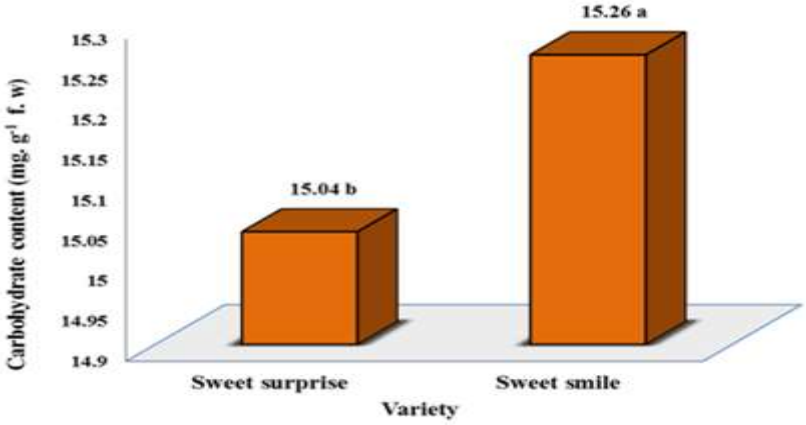

Figure 4. Effect of cultivars on carbohydrate content (mg. g^{-1}) of cut flower - *Gerbera jamesonii* Hook flowers cv. 'Sweet surprise' and 'Sweet smile.'

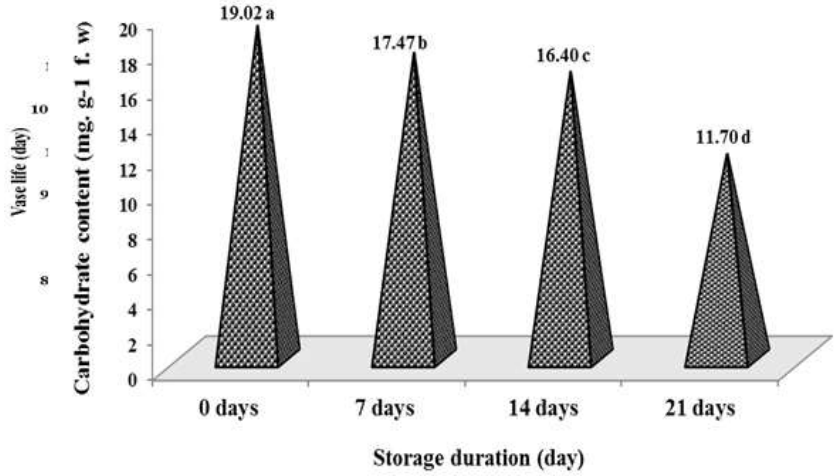

Figure 5. Effect of storage durations (days) on carbohydrate content (mg. g-1) of cut flower - *Gerbera jamesonii* Hook.

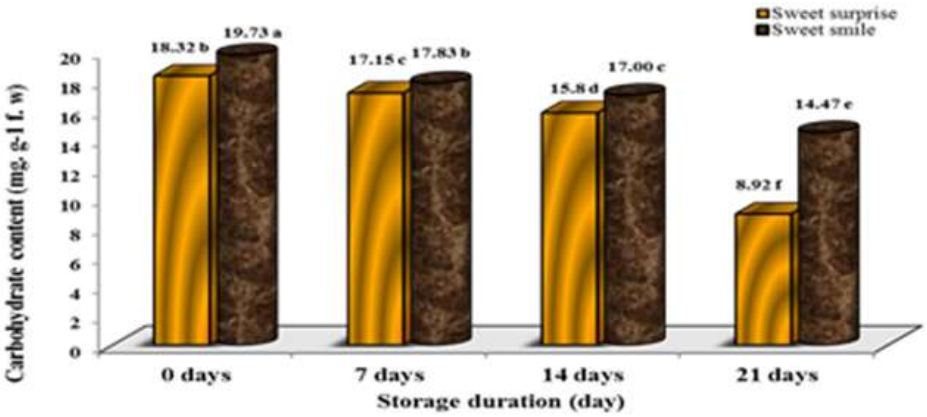

Figure 6. Interaction effect of cultivars and storage durations on carbohydrate content (mg. g^{-1}) of cut flower - *Gerbera jamesonii* Hook flowers cv. 'Sweet surprise' and 'Sweet smile.'

storage periods studied. Under the period of seven days of treatment, the carbohydrate content was lower than in the non-storage treatment but higher than in the other treatments.

In the cultivars sweet smile and sweet surprise, the values of carbohydrates content were 17.83 and 17.15 with the same seven days of storage period (Figure 6). This parameter under the interaction of cultivars and storage periods revealed the values as significantly varied. The longer the storage period with the cultivar sweet smile, the lowest the number of carbohydrates observed. The lowest content recorded was 8.92 compared to 14.47 mg g^{-1}.

DISCUSSION

Given that low temperatures reduce the physical activities and metabolism of pests leads to less potential for infections and diseases. In turn, this resulted in an improvement in quality parameters and a reduction in postharvest losses (Galati *et al.*, 2021). The study results agreed with the findings of Manfredini *et al.* (2017), who concluded that cold storage for two days affected the roses' cultivar 'Avalanche plant,' resulting in better quality and post-harvest durability. On the other hand, cut flowers lived a long time in the vase when storage periods were the least. It indicated that the flower's life deteriorated when stored could be due to a rapid decrease in the sugar content (Ali and Asal, 2022).

Past results revealed that vase life was significantly ($P < 0.05$) extended from 12.0 days (control) to 24.5 days by using a combination of aluminum sulfate at 300 ppm and sucrose (Amiri *et al*., 2009). A belief suggests that the maintenance of the carbohydrates pool in flower corolla is one critical factor for senescence delay (Jahnke *et al.*, 2020). The results also corroborate with Sarmah *et al*. (2014) and Sil *et al*. (2017), who recorded similar variations in productivity and vase life among the gerbera cultivars under protected cultivation. The variation in vase life under different treatments can mainly refer to the type of cultivar used. A report stated that the cultivars managed vase life variation, with the increase in vase life of the gerbera cultivar also recorded with the lengthiest life than other studied cultivars (Acharya *et al.*, 2010).

Non-stored flowers had superiority over flowers stored in cold storage for different periods. It can be due to reduced respiration and metabolic rate of the flowers. The ethylene-induced disorders rate and ethylene production also highly decreased at lower storage temperatures, which improved the quality of postharvest lasting of the cut flowers. The flower quality parameters and postharvest quality of cut flowers showed significant differences in various Gerbera (*Gerbera jamesonii* L.) cultivars, which conformed with the present findings (Mahmood *et al*., 2013).

The observed carbohydrate content experienced reduction with longer storage periods. One of the reasons for this may be the linkage with vase life, and the low amount of carbohydrates led to less vase life (Van-Doorn *et al.,* 1991; Pettersen and Gislerod, 2003). Also, a reduction in carbohydrate values can occur because of the transporting of carbohydrate forms, with the content decreasing in one state but increasing in another (Ranwala and Miller, 2008; Kim and Oh, 2021).

Past findings also revealed that applying 3% CA with O_2 and 6% CO_2 at 1 °C gave significant quality maintenance for 14 and 21 days, which were suitable for rose cut flowers (Dias *et al.*, 2017). A dry, cold storage may be beneficial to keep Lilium inflorescences for a longer period. The quality and postharvest losses of Lilium inflorescences showed improvement due to the metabolic and physical activity of pests and pathogens prevented at low temperatures (Nowak and Mynett, 1985).

CONCLUSIONS

Investigating cut flower *Gerbera jamesonii* quality is in the interest of growers and researchers, with improvement in cut flower plants a big aim. Various cultivars and storage periods differently affected these plant flowers' vase life and carbohydrate content. Fewer storage periods resulted in longer vase life of the flowers. The gerbera cultivar 'sweet smile' proved superior in vase life and carbohydrate content, which can be stored for 21 days at 5 °C compared with the cultivar 'sweet surprise.'

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