

EFFECT OF GAMMA IRRADIATION AND SOME HOLDING SOLUTIONS ON VASE LIFE OF GERBERA CUT FLOWERS

Ola A. Amin; Azza M. Abdel-Moneim and Hanan M.A. Youssef

Ornamental Plants and Landscape Gardening Res. Dept., Hort. Res. Inst., ARC, Giza, Egypt.



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Revised by:
Prof. Dr. E.S. Nofal,
Kafr El-Sheikh Univ.

Prof. Dr. A.Z. Sarhan,
Cairo Univ.

ABSTRACT: Nowadays, the most of investigations are directed towards the using of natural materials for reducing pollution environment. So, this study was consummated at Post-Harvest Lab. of Floriculture Dept., Hort. Res. Inst., Giza, Egypt during 2012 and 2013 seasons to study the effect of some holding solutions, viz. distilled water (control), calcium chloride (1 & 3 g/l), calcium claw (1 & 3 g/l), egg shell (0.5 & 1.5 g/l), oysters (0.5 & 1.5 g/l), humic acid (50 & 150 g/l) and three doses of gamma irradiation (100, 200 & 400 Gy) on longevity of flower heads (vase life), water uptake, water loss, relative fresh weight, dry weight and flower diameter of *Gerbera jamesonii*, cv. Rosalin & Express cut flowers. The obtained results cleared that application of CaCl_2 (1 or 3 g/l) with HQ 0.2 g/l and 20 g/l sucrose resulted in a great extension in vase life and water uptake more than other treatments. Rosalin cultivar recorded significant increase in longevity, water uptake comparing to gerbera cut flowers of cv. Express during the two seasons. Gamma ray (200 Gy) recorded the least rate of water loss in cv. Rosalin in the two seasons. Superiority was for the treatment with oysters (1.5 g/l) in improvement of relative fresh weight in both seasons followed by gamma ray (200 Gy), also gamma irradiation at the doses 200 Gy plus CaCl_2 at 1 g/l + sucrose at 20 g/l significantly increased dry weight of the two cultivars Rosalin and Express followed by claw (1 g/l). All treatments gave higher record in comparison with control for diameter. The present research indicated that the application of CaCl_2 (1 g/l) with HQ 0.2 g/l and 20 g/l sucrose after exposure of cut flowers to irradiation with gamma at (200 Gy) maximizes flower diameter. Results showed that, treating with CaCl_2 at 3 g/l + HQ at 0.2 g/l and suc. at 20 g/l, or gamma rays at 200 Gy + CaCl_2 at 1 g/l + HQ at 2 g/l + Sucrose at 20 g/l registered the highest increments in chlorophyll a in the stems and soluble sugars in the stems and petals. It is concluded that the use of the holding solution containing calcium chloride at 3 g/l plus hydroxyqenolin plus sucrose alone or after irradiation with gamma at 200 Gy gave the maximum vase life.

Key words: Vase life *Gerbera jamesonii*, cv. Rosalin & Express, calcium chloride, calcium claw, egg shell, oysters, humic acid, gamma irradiation, water uptake, water loss.

INTRODUCTION

Gerbera is a genus of ornamental plants from the family Asteraceae. It has approximately 30 species in the wild, extending to South American, Africa and

tropical Asia. Besides floral arrangements, gerbera is widely used in bouquets. *Gerbera jamesonii* is one of the ten most popular commercial cut flowers in the world and according to the global trends in floriculture,

it occupies the fourth place among cut flowers (Choudhary and Prasad, 2000).

Gerberas are valued for their brightly coloured daisy like flowers. Flowers are available in a wide range of colors, including yellow, orange, pink, crimson, red, purple and white. *Gabera jamesonii* is native to South Africa (Transvaal and Natal Provinces) and Swaziland (Emongor, 2004). Dineshababu *et al.* (2002) reported that holding solutions containing 8-HQS + sucrose extended the vase life of *Dendrobium* flowers and improved flower quality, as suggested by improved water consumption, fresh weight and flower freshness. This treatment also reduced the respiration rate and physiological loss in weight.

Chen *et al.* (2004) pointed out that cut flowers of *Gerbera hybrida* were steeped in CaCl_2 solution and their flowering period had been prolonged.

Application of CaCl_2 extended the vase life of flowers and reduced flowers bending of gerbera (Gerasopoulos and Chebli, 1999).

Bulent and Senay (2012) found that Ca treatment with NA and MA significantly reduced postharvest quality losses of gerbera (*Gerbera jamesonii* cv. Rosalin). Chutichudet and Chutichudet (2012) reported that, applications of CaCl_2 at 0.4 and 0.8% were found to be not the appropriate substances for maintaining the quality and prolonging the vase life of the patumma's flower.

Samaneh *et al.* (2015) found that 8-HQS increased vase life, dry weight, flower diameter, mean absorbed preservative solution and quality score. Also, decreased the stem curvature. Sucrose decreased vase life, flower diameter and quality score, whereas increased dry weight of cut Gerbera flower.

The egg shell consists 95% of the weight of calcium carbonate and 3.5% of the remaining organic material is a mixture according to Daengprok *et al.* (2003).

Oysters are an excellent source of zinc, iron, calcium, and selenium, as well as vitamin A and vitamin B₁₂. Oysters are low in food energy; one dozen raw oysters contains 110 kilocalories (460 kJ). Mollusks (2011).

Dietary supplements may contain calcium carbonate from oyster shells, though no evidence shows this offers any benefits beyond what calcium may offer. The post-harvested vegetables can be irradiated with gamma rays or electron beam to attend the phytosanitary requirements. Some previous researches indicate the effectiveness of radiation for disinfestations of flowers (Hayashi *et al.*, 1998; Kikuchi, 2000; Tanabe and Dohino, 1995). Placing chrysanthemum stems in 2% sucrose before and during irradiation did not influence the vase-life, but placing chrysanthemum stems in 2% sucrose following irradiation prolonged the vase-life (Hayashi and Dohino, 1995; Hayashi and Todoriki, 1996). These results indicate that sugars influence post-irradiation metabolism responsible for radiation-induced deterioration of chrysanthemum cut flowers. Dohino and Hayashi (1995) cleared that irradiation reduced ethylene production by cut flower.

Uthairatanakij *et al.* (2005) found that after harvesting, inflorescences were held in distilled water or holding solution containing 4% glucose + 220 mg/l HQS + 30 mg/l AgNO_3 and irradiated with gamma ray at 2.5 kGy. CaCl_2 spraying reduced flower dropping compared to control treatment. The beneficial vase solutions on irradiated flowers were to increase bud opening and reduce respiration rate, ethylene production and prolonged vase life up to 3 days at 25°C.

Miscellaneous evidence has demonstrated that humic acid plays an important regulatory role in multiple plant physiological processes as a plant growth regulator and delays the process of senescence in flowers (Nardi *et al.*, 2002). A pulse treatment of the flower with 1000 ppm humic acid was found as the most suitable treatment in preventing the flower from leaf

yellowing (Keshavarzi and Chamani, 2011). Vase life for up to 10 days and petal protein contents (32.76%) in *Chrysanthemum (Dendranthema grandiflorum)* flower was improved with respect to control when humic acid was applied with another compound Samiee *et al.* (2013). Kikuchi *et al.* (1995) irradiated Yellow mini-chrysanthemums in a Cobalt-60 gamma cell at the dose of 900 Gy (467 Gy/h) one day after harvest. Samples of 50 flowers, partially opened buds were used to estimate the flower viability. Aluminum sulfate and 8-hydroxyquinoline sulfate were used as two preservative solutions aiming to protect the cut flowers. Results indicated that the stem immersion in the preservative solutions after the irradiation treatment was an efficient procedure, stimulating the flowers development and maintaining the vase-life almost as long as the controls.

It would be possible to use preservative solutions to minimize the damaging effects of the ionizing radiation on chrysanthemum cut flowers, maintaining at the same time the disinfection action of radiation process. Radiation could be an effective treatment against insects that will prevent their reproduction in the host country. The radiation treatment could be also an alternative to substitute chemical fumigation with methyl bromide, which destroys the ozone layer of the earth.

The cut flower is an alive organism and in some cases it continues developing during its vase-life. It can be composed of one or many flowers, and may include leaves and stem, or only flower and stem. Some are harvested as bud and others after the blossom. The vase-life varies with the species or cultivar. Handling and environmental conditions during the vase-life can also affect flower vigor. Infestation by pests can drastically damage the final product, so that it can be considered commercially unsuitable. Flowers do not differ from other biological organisms in that they can be damaged by radiation, depending on the dose. Some authors have irradiated

cut flowers with gamma-radiation [Haasbroek, *et al.*, 1973; Hayashi, 1996], while others have used electron beams [Tanabe and Dohino, 1993 and 1995] for disinfection. To avoid the deleterious effects of radiation, cut flowers can be supplied with preservative or holding solutions containing sugar [Haasbroek *et al.*, 1973; Kikuchi, 1995; Hayashi, 1996]. Unfortunately, this procedure also must be adopted by the florist and the final consumer to assure continued flower quality during the vase-life.

Hamidah *et al.* (2006) found that, tolerant dose of cut flowers is the highest dose that can be applied to the plant without any visible injuries in terms of quality and appearance. The tolerant dose for roses is 100 Gy, for carnation 200 Gy, for orchids 100-300 Gy depending on the variety tested. The cut chrysanthemum can tolerate 200-400 Gy depending on the variety tested. However, chrysanthemum in 4% sucrose solution can tolerate doses of 750 Gy. Based on the obtained results, the quarantine sterilizing dose for *tetranychuspiercie* is 350 Gy and it is only suitable for chrysanthemums. Similar observations were also gained by Mencarelli *et al.* (1995); Amariutei *et al.* (1995); Nagaraja *et al.* (2000) and Emongor (2004) on gerbera, as well as Celikel and Karaaly (1995) on carnation, Reyes-Arribas *et al.* (2000) on *Chrysanthemum* cvs. Tara and Boaldi and Singh and Tiwari (2002) on rose cv. Dorris.

This trial aims to examine the effect of some holding solutions which contained either of calcium ,egg shell, oysters, humic acid and gamma irradiation amended with sucrose on quality, longevity, water relations and stem and petal chemical composition of cut gerbera (cv. Rosalin and cv. Express) flower heads .

MATERIALS AND METHODS

A study was conducted at Post-Harvest Lab. of Floriculture Dept., Hort. Res. Inst., Giza, Egypt, during 2012 and 2013 seasons in order to determine the best treatment suitable for improving the flowers keeping

quality and detecting some morphological and physiological changes occurring during the vase life period of the cut Gerbera flowers.

Flower heads of *Gerbera jamesonii*, cvs. Rosalin & Express were freshly obtained from Floramix Farm (El-Mansouria, Giza) grown under standard cultural practices in a commercial greenhouse. The flower heads were picked in the early morning at the export stage. Immediately following harvest (1 h) flowers were transported to the laboratory. The end of stems were recut and placed in graduated cylinders (3 flower heads/cylinder) containing one of the following holding solutions:

- 1- Distilled water (referred to as control).
- 2- CaCl₂ (1 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) solution.
- 3- CaCl₂ (3 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) solution.
- 4- Egg shell (0.50 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) solution.
- 5- Egg shell (1.50 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) solution.
- 6- Calcium claw (1 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) solution.
- 7- Calcium claw (3 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) solution.
- 8- Oysters (0.50 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) solution.
- 9- Oysters (1.50 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) solution.
- 10- Humic acid (actosol®) (50 g/l) + CaCl₂ (1 g/l) + sucrose (20 g/l) solution .
- 11- Humic acid (actosol®) (150 g/l) + CaCl₂ (1 g/l) + sucrose (20 g/l) solution.
- 12- Gamma rays at 100 Gy+ CaCl₂ (1 g/l) + HQ (0.2 g/l) + sucrose (20 g/l).
- 13- Gamma rays at 200 Gy + CaCl₂ (1 g/l) + HQ (0.2 g/l) + sucrose (20 g/l).
- 14- Gamma rays at 400 Gy + CaCl₂ (1 g/l) + HQ (0.2 g/l) + sucrose (20 g/l).

The chemical composition of egg shell was 91.1% ash, 7.56% protein, 0.24% lipid, 36.4% calcium, 0.002% iron, 0.097% potassium, 0.398% magnesium, 0.152% sodium, 0.091% sulfur, and 0.116% phosphorus (Walton *et al.*, 1973).

Oysters are an excellent source of zinc, iron, calcium, and selenium, as well as vitamin A and vitamin B₁₂. Oysters are low in food energy; one dozen raw oysters contain 110 kilocalories (460 kJ) (Mollusks, 2011). Humic acid (commercial liquid organic fertilizer (micronutrients actosol®) containing 2.9% humic acid plus 0.5% from each of Fe, Zn, Mn and Cu).

Stalks were irradiated at the Middle Eastern Regional Radioisotope Center for the Arab Countries, Dokki, Giza using gamma cell (Co 60) at 0, 100, 200, 400 Gy for 6 min and 14 sec.

The flower heads were held under a 24 h photoperiod (fluorescent light of 1000 lux) at 20±1 °C and approx 85% relative humidity. During the vase life period, some data were recorded every three days as follows: longevity (vase life) (days), water uptake (g/flower), water loss(g/flower), flower diameters (cm), relative fresh weight (%) and dry weight (%).

Chlorophyll a, b and carotenoids (mg/g f.w.) content were determined in fresh stem samples according to the method of Saric *et al.* (1967), while in fresh petal samples, carotenoids content was only evaluated. In fresh stems and petal samples, however, total soluble sugars (g/100 g) were measured as described by Dubois *et al.* (1956).

The design used was a completely randomized design in a factorial experiment as described by Snedecor and Cochran, (1972) at 5% probability level. Data obtained were statistically analyzed using MSTAT Computer Program (1985). Means were compared by Duncan's multiple range test (1955), which was used to verify the significance level among means of various treatments.

RESULTS AND DISCUSSION

Effect of holding solutions on:

1. Vase life of cut flower heads:

Data presented in Table (1) show that flower stems kept in water containing CaCl_2 , Ca claw, oysters had significantly increased vase life relative to the control for all concentrations in both cultivar Rosalin & Express in the two seasons and application of CaCl_2 (1 or 3 g/l) with HQ at 0.2 g/l and 20 g/l sucrose resulted in a greater extension in vase life than other treatments, these results are in accordance with those reported (Cortes *et al.*, 2011) that treatment with CaCl_2 + suc. + HQS also had the greatest vase life in *Rosa hybrida* cv. Grand Gala. It is concluded that the combined effect of Ca as a flow resistance reducer and HQS as a germicidal agent contributed to improve vase life. (Ibrahim *et al.*, 2011) found that, The chemical solutions of 8-HQS at 100 or 200 ppm or CaCl_2 at 1000 or 2000 ppm each supplemented with 4% sucrose increased longevity of gerbera cut flowers, Dineshababu *et al.* (2002) reported that holding solutions containing 8-HQS + sucrose extended the vase life of Dendrobium flowers.

Gamma (200 Gy) + CaCl_2 + HQ + suc. was the best treatment between radiation the two cultivars in all seasons and gave a significant finding, this agreed with the results found by (Hayashi and Todoriki, 1996) that holding chrysanthemum cut flowers in a sucrose solution before and during irradiation did not influence the vase life, but holding the cut flowers in a sucrose solution following irradiation prolonged the vase life. Uthairatanakij *et al.* (2005) on cut Dendrobium flowers demonstrated that, the beneficial effects on vase solutions in irradiated flowers were to increase bud opening and reduced respiration rate, ethylene production and prolonged vase life up. However, the shortest vase life in cv. Rosalin was given by humic acid in the two doses used, these results are in harmony with those of the shortest vase life were related to humic acid in cut roses (Mojgan *et al.*,

2013). Vase life of gerbera cut flowers differed among the different treatments. Maximum vase life in Rosalin cultivar (15 d) was noticed due to CaCl_2 (3 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) while the maximum vase life in Express cultivar (14 d) was noticed in two treatments CaCl_2 (3 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) solution and egg shell (1.50 g/l) + HQ (0.2 g/l) + sucrose (20 g/l) solution. In cv. Express all treatments gave maximum value over than control treatment giving the minimum value in both seasons.

Regarding the effect of gerbera varieties Rosalin and Express on longevity of flower heads (days), Rosalin cultivar (Table, 1) recorded highly significant increase in longevity comparing to gerbera cut flowers cv. Express during the two seasons, the results were in harmony with the findings of Nazari *et al.* (2011) who indicated that many cultivars of gerbera had high vase life, while many cultivar had low vase life and some of them had moderate vase life. On the other hand, other cultivars had minimum vase life. Emongor (2004) demonstrated that genetic factor has a critical role in vase life of gerbera.

2. Water uptake:

Water uptake as shown in Table (2) recorded maximum value in CaCl_2 (3 g/l) + HQ + suc. (75.24 g/l) in cv. Rosalin, and CaCl_2 (1 g/l) + HQ + suc. (52.13 g/l) in cv. Express that was cleared in the second season as treatment with CaCl_2 achieved significant increasing in water uptake in both cultivars (84.20 in cv. Rosalin, 56.82 in cv. Express). On comparison of both cultivars for water uptake cv. Rosalin was found superior over cv. Express in the two seasons. In this concern, Dineshababu *et al.* (2002) reported that holding solutions containing 8-HQS + sucrose improved flower of Dendrobium flowers quality, as suggested by improved water consumption. Similarly Cortes *et al.* (2011) on cut flowers of rose mentioned that the CaCl_2 + suc. + HQS treatment induced a greater water flow and the most color infiltration through the

Table 1. Effect of holding solution treatments on vase life of *Gerbera jamesonii*, cv. Rosalin and Express flower heads (days) during the vase life period of 2012 and 2013 seasons.

Treatments	Rosalin	Express	Mean
First season: 2012			
D.W. (Control)	10.00ef	7.00h	8.50e
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	14.00ab	13.00bc	13.50a-c
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	15.00a	14.00ab	14.50a
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	14.00ab	14.00ab	14.00ab
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	11.50c-e	14.00ab	12.75b-d
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	14.00ab	9.00fg	11.50d
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	14.50ab	11.50c-e	13.00bc
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	12.00cd	11.00de	11.50d
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	14.17ab	10.67d-f	12.42cd
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	9.00fg	8.00gh	8.5e
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	9.00fg	9.00fg	9.00e
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	9.00fg	10.50d-f	9.75e
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	14.00ab	14.00ab	14.00ab
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	10.00eg	9.00fg	9.50e
Mean	12.15a	11.05b	
Second season: 2013			
D.W. (Control)	10.00cd	7.00f	8.50e
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	14.00ab	13.00b	13.50a
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	14.00ab	14.00ab	14.00a
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	14.ab	14.00ab	14.00a
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	13.00b	14.00ab	13.50a
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	14.00ab	9.00de	11.50b
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	15.00a	8.00ef	11.50b
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	14.00ab	8.00ef	11.00bc
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	13.00b	13.00b	13.00a
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	9.00de	8.00ef	8.50e
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	9.00de	9.00de	9.00de
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	9.00de	9.00de	9.00de
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	14.00ab	14.00ab	14.00a
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	11.00c	9.00de	10.00cd
Mean	12.36	10.64b	

Means having the same letter are not significantly differed at .05 level of probability.

Table 2. Effect of holding solution treatments on water uptake of *Gerbera jamesonii*, cv. Rosalin and Express flower heads (g/flower head) during the vase life period of 2012 and 2013 seasons.

Treatments	Rosalin	Express	Mean
First season: 2012			
D.W. (Control)	65.43ab	50.95c-h	58.19ab
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	59.37bc	52.13c-g	55.75a-c
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	75.24a	48.15d-h	61.70a
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	57.36b-f	51.11c-h	54.24a-d
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	53.77c-g	48.26d-h	51.02b-e
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	46.20g-k	43.93g-l	45.07e-h
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	58.26b-d	49.61c-h	53.94b-d
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	57.86b-e	37.38i-n	47.62d-g
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	57.10b-f	40.80h-m	48.95c-f
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	47.30e-i	34.99l-	41.15gh
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	49.99c-h	27.74n	38.87h
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	46.26g-j	32.2mn	39.23h
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	40.58h-m	35.62k-n	38.10h
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	47.09f-i	36.30j-n	41.70f-h
Mean	54.42a	42.08b	
Second season: 2013			
D.W. (Control)	63.07d	52.17gh	57.62c
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	58.06e	53.64g	55.85d
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	84.20a	56.82ef	70.51a
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	55.28f	57.04e	56.16d
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	52.22gh	50.02ij	51.12f
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	43.03l	43.21kl	43.12h
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	58.40e	42.14lm	50.27f
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	67.32c	40.82m	54.07e
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	72.16b	50.84hi	61.50b
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	44.82k	31.01o	37.92j
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	55.30f	22.19q	38.75ij
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	48.60j	42.00lm	45.30g
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	37.79n	29.66o	33.73k
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	52.95g	25.33p	39.14i
Mean	56.66a	42.64	

Means having the same letter are not significantly differed at .05 level of probability.

vascular tissue compared to the sucrose treatment alone. Van Doorn and Witte (1994) pointed out that in gerbera cut flowers, It can be explained that application of these chemical preservatives 8-HQS, calcium chloride probably reduced microbial contamination in flower stems or vase water and consequently improved water conductance by preventing bacterial growth and reducing occlusions, also Ichimura *et al.* (2005) reported that the treatment with HQS improved water consumption and this was likely due to its acidifying effect that inhibits vascular occlusion caused by microorganisms .however, the lowest was recorded by gamma (200 Gy) + CaCl₂ (1 g/l) + HQ + suc. in cv. Rosalin in the two seasons, and treatment with HA (150 g/l + CaCl₂ + suc.) gave the lowest value of absorbent of solution in cv. Express in both seasons Mojgan *et al.* (2013) pointed out that a solution of humic acid decreased vase life of cut flowers of *Rosa hybrida* cv. White Naomi and reducing uptake solution rate by flowers. The treatment of gamma (400 Gy) + CaCl₂ + HQ + suc. was the best treatment for cv. Rosalin in the two seasons (Table, 2) The beneficial effect of vase solutions on irradiated cut *Dendrobium* flowers was to reduced ethylene production (Uthairatanakij *et al.*, 2005).

3. Water loss:

Termination of vase life for cut flowers is characterized by wilting associated with an imbalance developing between water uptake through xylem conduits in stems and water loss through stomata and other structures on leaves and other organs. To better understand the onset of adverse postharvest water relations, cut flower researchers seek to acquire data on rates of water uptake and water loss. These indices are usually monitored by weighing stems and vases daily or thereabout with a single analytical balance (He *et al.*, 2006; Lü *et al.*, 2009; Macnish *et al.*, 2008).

Gamma (200 Gy) gave the least rate of water loss in cv. Rosalin in the two season

and priority to the control Mohammad *et al.* (2009) attributed the beneficial effect of sugar in vase solutions that, sugars contribute to the osmotic potential of tissues and maintain the respiration rate. Table (3) cleared that, in cv. Express HA was the perfect treatment in this concern .Coefficient with gamma (200 Gy) on cut flowers of gerbera was the fewest in perishing water compared with other treatments, supervened with gamma (400 Gy). These results are in harmony with those reported by Uthairatanakij *et al.* (2005) the beneficial effect of vase solutions in irradiated flowers to reduced respiration rate in cut flowers of *Dendrobium*.

4. Relative fresh weight:

During the entire period of observation, the relative fresh weight of cut flower was found to be maximum in vase solution containing oysters (1.5 g/l) in both seasons (97.99-97.33% respectively) in cv. Rosalin while control was (68.22-60.21% respectively), and treatment with humic acid gave great result too with all concentrations, where with the low concentration of humic gave (94.76 - 94.48%, respectively) and with the high concentration (95.76 - 95.22%, respectively). These results are in accordance with those reported by Khenizy *et al.* (2013) on gerbera who found that humic acid at 25 and 50 ml/l and solution (A) [silver nitrate (150 mg/l) + salicylic acid (150 mg/l) + sucrose (2%) + 8-hydroxyquinoline citrate (8-HQC 200 mg/l)] had a superior effect on flowers fresh weight percentage. All treatments were higher than control in cv. Rosalin in the two seasons including CaCl₂ (3 g/l), similarly in gerbera (Ibrahim *et al.*, 2011), found that, the chemical solutions of 8-HQS at 100 or 200 ppm or CaCl₂ at 1000 or 2000 ppm each supplemented with 4% sucrose lowered the flower weight loss. Treating with oysters (1.5 g/l) gained an evident increment comparing to control which was the lowest followed by HA (150 g/l) in the two seasons.

Table 3. Effect of holding solution treatments on water loss of *Gerbera jamesonii*, cv. Rosalin and Express flower heads (g/flower head) during the vase life period of 2012 and 2013 seasons.

Treatments	Rosalin	Express	Mean
First season: 2012			
D.W. (Control)	56.61a-f	53.82b-f	55.22a
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	62.29ab	54.68a-f	58.49a
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	64.11a	50.39c-h	57.25a
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	59.22a-d	52.93b-f	56.08a
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	57.23a-e	49.76c-h	53.50ab
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	48.12e-h	46.82f-h	47.47bc
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	59.39a-c	52.29b-g	55.84a
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	53.16b-f	31.38kl	42.27cd
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	61.92ab	40.68h-k	51.30ab
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	48.28e-h	27.13l	37.71d
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	50.82c-h	31.08kl	40.95cd
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	49.05d-h	34.80j-l	41.93cd
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	42.05g-j	35.60j-l	38.83d
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	46.36f-i	36.38i-l	41.37
Mean	54.19a	42.70b	
Second season: 2013			
D.W. (Control)	69.63b	55.58f	62.61b
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	61.72c	55.21f	58.47c
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	68.2b	59.84d	63.93a
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	57.63e	59.74d	58.69c
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	56.24ef	51.28ij	53.76e
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	44.96m	47.90k	46.43h
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	60.24cd	52.93gh	56.59d
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	53.39g	27.15q	40.27i
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	77.59a	50.31j	63.95a
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	45.80lm	34.08o	39.94i
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	51.41h-j	51.40h-j	51.41f
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	52.75g-i	47.11kl	49.93g
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	40.66n	29.71p	35.19k
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	50.38j	25.68q	38.03j
Mean	56.46a	46.28b	

Means having the same letter are not significantly differed at .05 level of probability.

Table 4. Effect of holding solution treatments on relative fresh weight of *Gerbera jamesonii*, cv. Rosalin and Express flower heads (%) during the vase life period of 2012 and 2013 seasons.

Treatments	Rosalin	Express	Mean
First season: 2012			
D.W. (Control)	68.22k	80.00g-i	74.11f
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	80.62f-i	90.45a-e	85.54c-e
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	92.19a-e	84.73d-h	88.46b-d
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	89.63a-f	88.84b-g	89.24a-d
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	77.91hi	88.12c-g	83.02de
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	85.33d-h	84.20e-h	84.77c-e
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	93.61a-d	88.17c-g	90.89a-c
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	68.62jk	77.70h-j	73.16f
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	97.99ab	92.35a-e	95.17a
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	94.76a-c	83.12e-h	88.94a-d
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	95.41a-c	71.97i-k	83.69de
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	79.99g-i	78.79hi	79.39ef
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	90.14a-e	98.79a	94.43ab
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	83.96e-h	97.73ab	90.85a-c
Mean	85.60a	86.07a	
Second season: 2013			
D.W. (Control)	60.21p	78.78ij	69.50f
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	76.00kl	87.82e	81.91d
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	78.12i-k	81.94gh	80.03e
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	87.24e	83.88fg	85.56e
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	75.30lm	87.70e	81.50de
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	84.42f	76.82j-l	80.62de
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	92.18d	77.80i-k	84.99c
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	65.30o	70.20n	67.75g
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	97.33ab	86.78e	92.06a
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	94.48c	79.86hi	87.17b
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	95.22bc	65.02o	80.12e
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	73.56m	68.36n	70.96f
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	82.62fg	98.52a	90.57a
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	75.31lm	96.20bc	85.76bc
Mean	81.23a	81.41a	

Means having the same letter are not significantly differed at .05 level of probability.

In Express cultivar, the treatment which gave the highest value was gamma (200 Gy, 400 Gy) in rest of the transactions of irradiation in the two seasons. However, HA at 150 g/l gave minimum results in each of seasons under this study. Ansari *et al.* (2011), found that on gerbera cut flowers humic acid at 50 mg l⁻¹ + sucrose 4% + GA 2.5 mg l⁻¹ gave the best fresh weight, while humic acid 50 mg l⁻¹ + GA 2.5 mg l⁻¹ had the least relative fresh weight. Also, Dineshababu *et al.* (2002) reported that holding solutions containing 8-HQS + sucrose extended the vase life of Dendrobium flowers and improved flower quality, as suggested by improved fresh weight. El-Saka (2002), on gerbera flowers cv. "North Star" mentioned that preservative vase solutions recorded higher rate daily fresh weight which increased as percentage. The flower weight expressed the flower freshness, flower longevity and flower senescence.

All treatments appeared arising in values over control in cv. Rosalin in both seasons. While when we compare between the two cultivars under study in terms of better treatment, we find that the transaction with oysters (1.5 g/l) was the superiority (95.17-92.06%) in both seasons followed by gamma (200 Gy) (94.47-90.57%) over control (74.11-69.50%). In this respect, Hayashi *et al.* (1998), mentioned that, gerbera was tolerant to electron beams at 400-600 Gy.

5. Dry weight:

Data concerning flower dry weight (%) as affected by gamma irradiation at the dose of 200 Gy plus CaCl₂ at 1 g/l + sucrose at 20 g/l (Table, 5) significant showed increased dry weight of the two cultivars Rosalin and Express followed by claw (1 g/l) where gave maximum results in both seasons. This agreed with the results found by Ibrahim, *et al.* (2011) who reported that, the chemical solutions of 8-HQS at 100 or 200 ppm or CaCl₂ at 1000 or 2000 ppm each supplemented with 4% sucrose increased dry weight percentage in cut flower of gerbera.

6. Diameter of flower head:

The flower diameter is a suitable index to flower opening and the stem diameter is important factor of flower quality and play important role in flower marketing. All treatments in this study produce higher rates compared with control but gamma 200 Gy and humic acid 150 g/l recorded the highest diameter in the two seasons of both cultivars. Similar results were achieved by Khenizy *et al.* (2013) on gerbera cut flowers the combined treatments of solution (A) [silver nitrate (150 mg/l) + salicylic acid (150 mg/l) + sucrose (2%) + 8-hydroxyquinoline citrate (8 HQC 200 mg/l) plus humic acid at 25 or 50 ml/l had a superior effect on extending life of flowers and increasing flower diameter (cm).

In cv. Express head flowers placement in holding solution containing Ca claw (1 g/l) plus HQ at 0.2 g/l and 20 g/l sucrose enhanced the flower diameter significantly in comparison with the other interactions in both seasons. On the other hand, flower head diameter (cm) of gerbera cv. Rosalin (Table, 6) appeared that holding flower in the holding solutions, HA (150 g/l) + CaCl₂ (1 g/l) + sug. (20 g/l) and gamma irradiation at the doses of 200 Gy plus CaCl₂ 1 g/l plus HQ at 0.2 g and 20 g/l sucrose caused increment in the flower head diameter to 12.50, 13.0 cm comparing with 10.50 & 10.50 cm compared with control (distilled water) in both seasons.

Data presented in the same Table (6) reflect the interaction between holding solution and varieties treatments on diameter of *Gerbera jamesonii*, cv. Rosalin and cv. Express flower heads during the vase life period of 2012 and 2013 seasons. It appeared that cv. Rosalin gave maximum diameter in the two seasons comparing to the other cultivar.

7. Chemical composition of stem and petal of *Gerbera jamesonii*:

Data presented in Table (7) clear the effect of CaCl₂, egg shell, Ca claw, oysters,

Table 5. Effect of holding solution treatments on dry weight of *Gerbera jamesonii*, cv. Rosalin and Express flower heads (%) during the vase life period of 2012 and 2013 seasons.

Treatments	Rosalin	Express	Mean
First season: 2012			
D.W. (Control)	20.03i-k	25.89e-h	22.96ef
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	28.30c-g	18.19jk	23.25ef
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	16.96k	17.55	17.26g
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	30.25c-e	28.80c-g	29.53bc
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	29.85c-f	28.94c-g	29.40bc
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	39.32a	28.93c-g	34.13a
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	27.16c-h	26.71d-h	26.94cd
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	31.18b-d	30.75c-e	30.97ab
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	22.61h-j	28.69c-g	25.65de
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	20.69i-k	24.40g-i	22.55ef
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	18.81jk	22.35h-j	20.58fg
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	24.20g-i	25.01f-i	24.61de
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	32.23bc	36.28ab	34.26a
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	26.96d-h	28.68c-g	27.82b-d
Mean	26.33a	26.51a	
Second season: 2013			
D.W. (Control)	19.96j-l	28.14e-g	24.05e
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	30.30d-f	18.53kl	24.42e
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	17.24l	17.56l	17.40g
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	29.79ef	30.85de	30.32b-d
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	34.73cd	30.80de	32.76bc
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	39.20bc	28.20e-g	33.70b
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	31.12de	27.92e-h	29.52cd
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	19.15j-l	30.31d-f	24.73e
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	23.20h-k	27.47e-h	25.33e
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	19.38j-l	25.95f-i	22.67ef
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	19.51j-l	20.00j-l	19.76fg
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	23.41h-j	22.08i-l	22.74ef
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	48.57a	40.11b	44.34a
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	29.94d-f	28.00e-h	28.97d
Mean	27.54a	26.85a	

Means having the same letter are not significantly differed at .05 level of probability.

Table 6. Effect of holding solution treatments on diameter of *Gerbera jamesonii*, cv. Rosalin and Express flower heads (cm) during the vase life period of 2012 and 2013 seasons.

Treatments	Rosalin	Express	Mean
First season: 2012			
D.W. (Control)	10.50g-i	10.00i-k	10.25f
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	11.50d-f	10.90f-h	11.20b-d
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	11.50d-f	10.10i-k	10.80de
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	12.27bc	10.25h-j	11.26a-d
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	12.00b-d	10.00i-k	11.00c-e
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	11.77cd	11.50d-f	11.64ab
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	12.00b-d	10.00i-k	11.00c-e
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	11.67c-e	10.27h-j	10.97de
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	12.27bc	10.10i-k	11.19b-d
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	12.50ab	10.50g-i	11.50a-c
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	13.00a	10.50g-i	11.75a
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	12.00b-d	9.77jk	10.89de
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	12.50ab	11.00e-g	11.75a
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	11.77cd	9.50k	10.64ef
Mean	11.95a	10.31b	
Second season: 2013			
D.W. (Control)	10.50c-e	10.00de	10.25d
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	11.50a-d	11.00b-e	11.25a-d
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	11.50a-d	12.20de	10.85a-d
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	12.50ab	11.00b-e	11.75ab
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	12.00a-c	9.50e	10.75b-d
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	12.00a-c	11.50a-d	11.75ab
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	11.50a-d	11.00b-e	11.25a-d
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	12.00a-c	9.50e	10.75b-d
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	12.50ab	10.30de	11.40a-d
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	12.50ab	11.50a-d	12.00a
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	13.00a	11.00b-e	12.00a
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	13.00a	10.00de	11.50a-c
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	13.00a	11.00b-e	12.00a
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	11.50a-d	9.50e	10.50cd
Mean	12.07a	10.50b	

Means having the same letter are not significantly differed at .05 level of probability.

Table 7. Effect of holding solution treatments on chemical composition of *Gerbera jamesonii*, cv. Rosalin and Express stem and petals during the vase life period of 2012 season.

Treatments	Chlorophyll a (mg/g f.w.)		Chlorophyll b (mg/g f.w.)		Carotenoids (mg/g f.w.)		Soluble sugars (g/100 g)			
	In the stems		In the stems		In the petals		In the stems		In the petals	
	Express	Rosalin	Express	Rosalin	Express	Rosalin	Express	Rosalin	Express	Rosalin
D.W. (Control)	0.29	0.31	0.21	0.24	0.70	0.81	1.79	2.10	2.18	1.14
CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	0.31	0.34	0.31	0.37	1.09	0.91	2.21	2.31	2.34	2.35
CaCl ₂ 3 g/l + HQ 0.2 g/l + suc. 20 g/l	0.32	0.34	0.26	0.33	0.73	0.84	1.94	2.12	2.31	2.38
Egg shell 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	0.34	0.35	0.32	0.35	0.66	0.77	2.14	2.14	2.12	1.13
Egg shell 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	0.36	0.37	0.33	0.38	0.66	0.77	2.14	2.18	2.16	1.69
Ca claw 1 g/l + HQ 0.2 g/l + suc. 20 g/l	0.39	0.41	0.44	0.45	1.78	1.56	2.19	2.29	2.39	2.39
Ca claw 3 g/l + HQ 0.2 g/l + suc. 20 g/l	0.43	0.45	0.45	0.42	0.77	0.88	2.28	2.59	2.29	2.39
Oysters 0.5 g/l + HQ 0.2 g/l + suc. 20 g/l	0.34	0.38	0.26	0.36	0.78	0.88	2.19	2.51	2.21	1.87
Oysters 1.5 g/l + HQ 0.2 g/l + suc. 20 g/l	0.36	0.37	0.36	0.37	1.14	0.91	1.65	1.98	2.34	2.35
Humic acid 50 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	0.38	0.40	0.41	0.42	1.73	1.51	2.09	2.19	2.28	2.39
Humic acid 150 g/l + CaCl ₂ 1 g/l + suc. 20 g/l	0.39	0.39	0.43	0.44	1.79	1.59	2.21	2.31	2.41	2.40
Gamma 100 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	0.41	0.44	0.42	0.45	1.80	1.59	2.23	2.30	2.42	2.36
Gamma 200 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	0.42	0.45	0.45	0.47	1.83	1.58	2.25	2.31	2.44	2.41
Gamma 400 Gy + CaCl ₂ 1 g/l + HQ 0.2 g/l + suc. 20 g/l	0.38	0.39	0.41	0.42	1.73	1.51	2.15	2.26	2.37	2.37

and three doses of gamma irradiation of *Gerbera jamesonii*, it could be concluded that chlorophyll a and b content in the stems (mg/g f.w.) was increased in response to all the used holding solutions comparing with control in the two cultivars. Treating with CaCl₂ at 3 g/l + HQ at 0.2 g/l and suc. at 20 g/l, or gamma rays at 200 or 400 Gy + CaCl₂ 1 g/l + HQ 0.2 g/l + sucrose at 20 g/l registered high increments in chlorophyll a in the stems and soluble sugars in the (stems, and petals) compared to other treatments. However, chlorophyll b in the stems and carotenoids in the petals contents recorded high increases with gamma rays at 200 Gy + CaCl₂ 1 g/l + HQ 0.2 g/l + 20 g/l sucrose in both cultivars. This agreed with Tanabe and Dohino (1993) they found that, color cannot be used as a reference to indicate if the flower is tolerant to radiation. *Alpinia*, *Curcuma*, *Eustoma* and *Gerbera* present some grades of petal discoloration with damaging doses of both kinds of radiation and this symptom can be a result of direct or indirect effects of radiation on pigments. Also Ibrahim *et al.* (2011) observed that in cut flowers of gerbera, the chemical solutions of 8-HQS at 100 or 200 ppm or CaCl₂ at 1000 or 2000 ppm each supplemented with 4% sucrose resulted in the highest soluble sugars content in petals of the flowers.

Farahat and Gaber (2009) mentioned that, window leaf cut foliage when holding in different preservative solutions recorded the highest content of total soluble sugars with CaCl₂ at the rate of 1000 ppm. However, 8-HQS 200 or 400 ppm + 30 g/l sucrose recorded the lowest values.

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تأثير التشعيع بأشعة جاما وبعض محاليل الحفظ على فترة بقاء ازهار الجيربيريرا

علا عواد أمين، عزة محمد عبد المنعم، حنان محمد أحمد يوسف

قسم بحوث الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر.

تتجه معظم الأبحاث في الآونة الأخيرة لتقليل التلوث البيئي باستخدام مواد طبيعيه لذلك أجريت هذا الدراسة بمعمل معاملات مابعد الحصاد بقسم بحوث الزينة، معهد بحوث البساتين، الجيزة، مصر خلال موسمي ٢٠١٢، ٢٠١٣ وذلك لدراسة تأثير بعض محاليل الحفظ: الماء المقطر (مقارنة) وكلوريد الكالسيوم بتركيز ١ و ٣ جرام/لتر وقشور البيض ٠,٥ و ١,٥ جرام وكالسيوم مخلي ١,٣ و ٣ جرام/لتر ومحار ٠,٥ و ١,٥ جرام/لتر وكل ذلك مضافا إليه هيدروكسي كينولين بتركيز ٠,٢ جم/لتر و ٢٠ جرام / لتر سكروز وأيضا حمض هيوميك بتركيز ٥٠ و ١٥٠ جرام/لتر مع أضافه ١ جرام/لتر كلوريد كالسيوم و ٢٠ جرام/لتر سكروز كذلك المعامله بأشعه جاما بجرعات ١٠٠ و ٢٠٠ و ٤٠٠ جرای مع أضافه ١ جرام/لتر كلوريد كالسيوم و HQ بتركيز ٠,٢ و ٢٠ جرام /لتر سكروز علي جودة الأزهار ومدة البقاء في الفازة و سمك الشمراخ الزهري و الوزن الطازج وكذلك النسبة المئوية للوزن الجاف للوزن الطازج والعلاقات المائيه والتركيب الكيميائي لسوق وبتلات أزهار الجيربيريرا صنفى Rosalin & Express (روزالين و اكسبرس).

ولقد أوضحت النتائج المتحصل عليها مايلي:-

المعاملة بكلوريد الكالسيوم بتركيز ١ او ٣ جم / لتر مع الهيدروكسي كينولين ٠,٢ جم/لتر و ٢٠ جم/لتر سكروز أدت لزيادة فترة بقاء الأزهار بالفازة وكذلك الإمتصاص بالمقارنة بباقي المعاملات. سجل صنف روزالين زيادة في فترة بقاء الأزهار بالفازة والماء الممتص بالمقارنة بالصنف اكسبرس في خلال موسمي التجربة.

أدت معاملة الأزهار بأشعة جاما بمقدار ٢٠٠ جرای للوصول لأقل فقد للماء من خلال أزهار صنف روزالين خلال الموسمين.

هناك تفوق للمعاملة ب ١,٥ جرام/لتر محار في التأثير على وزن الأزهار ثم المعاملة بأشعة جاما ٢٠٠ جرای والمعاملة بأشعة جاما قبل الوضع بمحلول كلوريد كالسيوم مع هيدروكسي كينولين بالإضافة للسكروز سجل زيادة في الوزن الجاف للأزهار في كلا الصنفين متبوعه بالمعاملة ب ١ جم/لتر كالسيوم مخلي.

كل معاملات التجربة كانت أكبر من الكنترول في قطر الأزهار ووجد مع المعاملة بكلوريد كالسيوم ١ جم/لتر مع الهيدروكسي كينولين ٠,٢ جم/لتر بالإضافة إلى ٢٠ جم/لتر سكروز بعد التعرض لأشعة جاما ٢٠٠ جرای كانت الأكثر في قطر الأزهار.

المعاملة بمحلول كلوريد كالسيوم او تعريض الأزهار للتشعيع بمقدار ٢٠٠ جرای ثم المعاملة بكلوريد كالسيوم مع الهيدروكسي كينولين مع السكروز أدت لزيادة في الكلورفيل أ والسكريات الذائبة في سوق وبتلات الأزهار.

الخلاصة أن المعاملة بكلوريد كالسيوم مع الهيدروكسي كينولين مع السكروز وحده او بعد المعاملة بالتشعيع بجاما ٢٠٠ جرای أدت لزيادة فترة بقاء الأزهار أكثر من الكنترول.

