Research Article

Optimization of Dehydration Techniques for Colour Retention and Other Qualitative Attributes of Gerbera (*Gerbera hybrida*) cv. 'Ruby Red'

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Abstract

Gerbera is the most popular commercial cut flower due to various colours, shapes and sizes. It belongs to the family Asteraceae. The present studies were conducted to determine the effect of different drying techniques on retention of flower colour and its related traits of *Gerbera hybrida* cv. 'Ruby Red'. Maximum flower colour acceptability score (2.67), high acceptability of texture of dry flowers (2.67), minimum brittleness of dried flowers (1.33), minimum damage of florets (1.33) and maximum score (2.00) for the shape of embedded dry flowers were observed with vacuum drying upto 60 days. Maximum colour retention up to 60 days was observed on the adaxial surface (G-O-176B) and abaxial surface (G-O-166C) of the floret in vacuum drying technique. Minimum per cent reduction in flower size (6.77 %) was observed in microwave drying technique however, minimum per cent reduction in flower weight (84.09 %) was found in vacuum drying. Vacuum drying method was observed to be the best technique for retention of flower colour and related traits.

Keywords: Dehydration, Flower colour, *Gerbera hybrida*, Qualitative attributes

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Introduction

Fresh flowers are very attractive, however, expensive, perishable and available only in particular production season. Whereas, dried flowers can be stored for a long period without losing their aesthetic value [1]. Dried flowers offer various advantages such as long lasting quality, year round availability, easy handling, low transportation cost, eco friendly and suitable for subsequent value added flower products viz., dried flower arrangements, pot pourris, wall hangings, paper weights, greeting cards, *etc.* The techniques of drying the flowers have tremendous importance in social development *w.r.t.* employment generation. The drying techniques reduce moisture content of flowers to a point where biochemical changes are minimized which maintain cell integrity resulting in well structure, petal pigment level and shape of flower without losing its decorative value. The range of dried flowers and other attractive plant parts is quite extensive, namely flowers, stems, leaves, roots, shoots, cones, seeds, foliage, bracts, thorns, barks, lichens, fleshy fungi, mosses, sellaginellas, *etc.* [2]. Besides natural flora, the commercial flowers are being utilized for making various value added flower arrangements and other products. Gerbera (*Gerbera hybrida*) is very popular and widely used as a decorative garden plant or as cut flowers. It is known for its flowers with attractive colours including white, yellow, orange, red, and pink. The flowers of gerbera are suitable for drying and further use in preparation of different kinds of value added products. There are various methods to dry the flowers such as by hanging them upside down, laying them flat (for flower heads), or pressing them under room temperature, air drying technique, microwave or vacuum flower drying techniques, *etc.* Optimizing an appropriate dehydration technique for better qualitative attributes is important for further support the entrepreneurs in the competitive global dried flower market. Therefore, the present investigation was carried out to determine the influence of different dehydration techniques on colour retention and other qualitative attributes in gerbera flowers.

Experimental

The present studies were carried out in the laboratory of Division of Floriculture and Landscaping, ICAR-Indian Agricultural Research Institute, New Delhi. The planting material utilized in the present study was the flowers of *Gerbera hybrida* cv. 'Ruby Red'. In present study, five drying techniques having three replications *viz.* microwave drying for 40 seconds (T_1), hot air oven drying at 45°C for 4 hours (T_2), vacuum drying at 40°C with pressure of 0.08K Pascal (T_3), room temperature drying at 25 ± 1°C (T_4) and control (T_0) (bloating paper drying) were used to dry

gerbera flowers. Silica gel white was used as base/embedding material in different drying techniques in the present study. Data on different observations like size, weight, colour, texture, brittleness, intactness and shape of dried flowers. Quality parameters like colour, texture, brittleness, intactness, shape and over all acceptability were assessed by means of sensory evaluation. Further, different parameters were scored on a variable point scale *i.e.* flower colour acceptability (1-non acceptable; 2-less acceptable; 3-acceptable; 4- highly acceptable), flower texture acceptability (1-non acceptable; 2-less acceptable; 3-acceptable; 4- highly acceptable), Flower brittleness (1- Very low; 2-low; 3-moderate; 4-high), Flower intactness (1- No damage; 2: 0-10% damage; 3-damage) and flower shape (1- distorted; 2-maintained; 3-well maintained). The data were subjected to completely randomized design by using OPSTAT statistical software.

Results and Discussion

Fresh flower colour of the adaxial and abaxial surfaces of florets of cv. 'Ruby Red' were R-G-40A and R-G-37A (Royal Horticultural Society colour chart), respectively. However, colour of dried flowers was found varied with different dehydration techniques as shown in **Table 1**. Maximum colour retention up to 60 days was observed on the adaxial surface of the floret in vacuum drying (G-O-176B) and room temperature drying (G-O-166A) followed by control and microwave drying. Whereas, minimum retention on the adaxial surface of the floret was found in hot air oven drying (G-P-183B, G-O-176A, G-O-166B) at 20, 40 and 60 days, respectively from the day of drying of flowers. Similarly, on the abaxial surface of the floret, colour retention was seen maximum upto 60 days at vacuum temperature drying (G-O-166C) technique followed by room temperature drying. However, minimum retention on the abaxial surface of the floret was observed in hot air oven drying (R-G-37A, G-O-164C, G-O-164A) and in control (R-G-37A, G-O-165C, G-O-164C) at 20, 40 and 60 days, respectively from the day of drying of flowers. Similar findings were also observed by Rohit and Namita [3] in cv. Doni of gerbera.

Table 1 Effect of dehydration techniques on flower colour (RHS Chart) of gerbera cv. Ruby Red

Treatment	Dry flower colour					
	Adaxial ray floret			Abaxial ray floret		
	20 days	40 day	60 day	20 days	40 day	60 day
Control (Bloating paper) (T_0)	R-G-40A	G-O-166A	G-O-166B	R-G-37A	G-O-165C	G-O-164C
Microwave (T_1)	R-G-40A	G-O-166C	G-O-166B	G-O-164C	G-O-165C	G-O-165C
Hot air oven (T_2)	G-P-183B	G-O-176A	G-O-166B	R-G-37A	G-O-164C	G-O-164A
Vacuum air oven (T_3)	R-G-40A	G-O-176B	G-O-176B	R-G-37A	G-O-164C	G-O-166C
Room temperature (T_4)	R-G-40A	G-O-166A	G-O-166A	R-G-37A	G-O-165C	G-O-165C

Size of dried flower and per cent reduction in flower size

Data presented in the **Table 2** shows the significant results with respect to size of dried flower of gerbera flowers embedded in silica gel under different drying techniques including control. The maximum size of dry flowers (90.96 mm) was observed in microwave drying technique which is significantly at par with vacuum air oven drying (89.11 mm) and room temperature drying (82.54 mm) whereas, minimum dry flower size (56.96 mm) was observed in control (T_0) (Table 2). Significant results were observed with respect to per cent reduction in size of gerbera flowers (Table 2). Minimum per cent reduction in size of flowers (6.77 %) was observed in microwave drying which is significantly at par with all the other treatments. However, maximum per cent reduction in size was observed in control (32.78 %). The variation in reduction of size may also due to at higher temperature, rate of moisture loss or liberation of moisture from flower tissues was more due to higher transfer of heat by conduction and convection. The results are in confirmation with the findings of Bhalla *et al.* [4].

Dry flower weight and per cent reduction in flower weight

Data presented in the Table 2 shows the significant results with respect to dry flower weight of gerbera flowers embedded in silica gel under different dehydration techniques, however, data was found non- significant with respect to per cent reduction in weight of gerbera flowers. The dry weight (1.78 g) of gerbera flowers was observed maximum in microwave drying which is significantly at par with vacuum air oven drying (1.74 g) followed by hot air oven drying (1.42 g) and control (1.24 g). However, minimum dry flower weight was observed in room temperature

drying (0.97 g) technique. Non-significant results were observed with respect to per cent reduction in weight of gerbera flowers (Table 2). Singh *et al.* [5] reported that temperature influences the qualitative and quantitative parameters where drying at higher temperatures results into rapid drying and low moisture content.

Data presented in the Table 3 reveals that significant changes were observed with respect to qualitative attributes such as colour acceptability, texture acceptability, brittleness, intactness and shape of gerbera flowers embedded in silica gel under different drying techniques.

Table 2 Influence of dehydration techniques on flower size, flower weight and per cent reduction in flowers of gerbera cv. Ruby Red

Treatment	Size of dried flower (mm)	% Reduction in flower size	Dry flower weight (g)	% Reduction in flower weight
Control (Bloating paper) (T_0)	56.96	32.78 (34.90)	1.24	85.73 (67.81)
Microwave (T_1)	90.96	6.77 (14.20)	1.78	84.35 (66.68)
Hot air oven (T_2)	79.89	10.53 (18.37)	1.42	85.57 (67.66)
Vacuum air oven (T_3)	89.11	9.01 (16.61)	1.74	84.09 (66.53)
Room temperature (T_4)	82.54	8.63 (16.91)	0.97	86.75 (68.66)
C.D. (0.05)	9.09	9.41 (9.76)	0.28	N/A (N/A)

*Values in parenthesis are of transformed values

Flower colour and texture acceptability

Maximum colour acceptability score (2.67) was observed with vacuum drying upto 60 days followed by hot air oven drying (1.67) and all other treatments (1.00) however, minimum flower colour acceptability (1.00) was found in microwave drying upto 20 days (Table 3). The maximum flower colour acceptability might be due to the low temperature and duration in a vacuum hot air oven, which leads to more retention of the pigment. Similar to our findings, Dahiya *et al.* [6] also reported that colour of chrysanthemum flowers was retained in an oven after embedding in silica gel.

The high acceptability of texture of dry flowers (2.67) was observed with vacuum drying upto 60 days followed by all other treatments (1.00). However, minimum texture acceptability was found in the treatments *i.e.* control (1.00) upto 40 days (Table 3). The efficacy in retention of flowers petal colour and texture in silica gel was also confirmed in flowers like Gomphrena, Ixora, Mussaenda, Sunflower, Plumeria, and Bauhinia by Pamela [7] and later on in different flower crops by Singh and Dhaduk [8].

Flower Brittleness

Minimum brittleness of dried flowers (1.33) was observed with vacuum drying upto 60 days followed by microwave drying (3.33), room temperature drying (3.67) and hot air oven drying (3.67) upto 60 days. However, maximum brittleness was found in control (4.00) (Table 3). Acharya *et al.* [9] also explained the minimum brittleness might be attributed to the slow removal of agitated water molecules from the petal surface by the drying and to the subsequent slow removal of moisture by silica gel.

Table 3 Effect of dehydration on colour, texture and brittleness of gerbera flowers cv. 'Ruby Red'

Treatment	Flower colour acceptability				Flower texture acceptability				Flower brittleness			
	1 day	20 day	40 day	60 day	1 day	20 day	40 day	60 day	1 day	20 day	40 day	60 day
Control (Bloating paper) (T_0)	2.00	2.00	1.67	1.00	2.00	1.00	1.00	1.00	2.67	2.67	3.67	4.00
Microwave (T_1)	1.33	1.00	1.00	1.00	2.00	1.67	1.33	1.00	2.33	2.67	3.33	3.33
Hot air oven (T_2)	3.33	3.00	2.00	1.67	3.33	2.67	1.00	1.00	2.33	2.67	3.33	3.67
Vacuum air oven (T_3)	3.33	3.33	3.00	2.67	2.67	2.67	3.00	2.67	3.00	3.00	1.33	1.33
Room temperature (T_4)	2.67	2.67	1.33	1.00	3.00	3.00	1.00	1.00	2.67	2.67	3.00	3.67
C.D. (0.05)	1.26	1.35	1.06	0.67	N/A	N/A	0.48	0.47	N/A	N/A	1.25	0.95

Flower Intactness

Data presented in Table 4 shows that the minimum damage of florets (1.33) was observed with vacuum drying followed by microwave drying (2.00) and room temperature drying (2.33) upto 60 days. However, maximum damage of florets (3.00) was observed with control followed by hot air oven drying (2.67). Singh *et al.* [5] reported that moisture content in dried flowers influence flower quality and longevity. According to them, excessive drying results into petal shedding during handling and moisture content below 8% also results in petal shedding. In our studies, deterioration of presentability under control conditions may be attributed to the reasons like absorption of moisture by the flowers from the atmosphere, thereby inviting fungal attack, spreading of dust on the flowers, shedding and shrivelling of petals, attack of insects due to presence of high sugar content, etc. Bhalla *et al.* [4] reported that the dried flowers remained in a more presentable state under covered conditions than those kept under open conditions.

Table 4 Influence of drying techniques on intactness and shape of the gerbera flowers cv. Ruby Red

Treatment	Flower intactness				Flower shape			
	1 day	20 day	40 day	60 day	1 day	20 day	40 day	60 day
Control (Bloating paper) (T_0)	2.00	2.00	3.00	3.00	1.00	1.00	1.00	1.00
Microwave (T_1)	1.33	1.33	2.00	2.00	2.00	2.00	1.67	1.00
Hot air oven (T_2)	1.33	1.67	2.67	3.00	2.33	1.67	1.00	1.00
Vacuum air oven (T_3)	1.33	1.33	1.33	1.33	2.33	2.33	2.67	2.00
Room temperature (T_4)	1.00	1.00	1.67	2.33	2.33	2.33	1.67	1.33
C.D. (0.05)	N/A	N/A	0.82	0.67	N/A	N/A	0.82	0.48

Flower Shape

Maximum score for the shape of embedded dry flowers was well maintained (2.00) in vacuum drying method followed by room temperature drying (1.33) upto 60 days. However, minimum retention of shape was observed in control (1.00) followed by hot air oven drying (1.67) upto 20 days (Table 4). Flower shape retention in different drying techniques obviously was due to embedding of flowers in the silica gel, as also suggested by Singh and Dhaduk [8] in different flower crops. Vacuum and microwave dried flowers retained their colour in the present study. However, the shrinkage of flowers was observed in microwave drying technique as compared to vacuum drying technique. Hot air oven drying technique shows that almost all the flowers retained colour but the petals become shriveled and lost their shape. Aravinda and Jayanthi [10] also standardized the drying techniques like microwave drying, oven drying and sun drying for chrysanthemum (Button type local) flowers.

Conclusion

In present studies, vacuum oven drying proved to be the best in respect to the drying and retention of flower colour and other qualitative attributes as compared to other drying techniques. Flowers embedded in silica gel resulted in maximum moisture loss and early drying, regardless of the different drying conditions. However, room temperature drying embedded in silica gel was also the effective method to retain the true colour of the gerbera flowers. Silica gel embedding coupled with vacuum oven drying technique, was the most suitable dehydration method for the gerbera cv. 'Ruby Red'.

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