Plant Archives Vol. 15 No. 1, 2015 pp. 27-33 ***ISSN 0972-5210***

EFFECT OF EMBEDDING MEDIA ON PRODUCTION OF QUALITY DRY FLOWERS IN CARNATION

S. Sindhuja, T. Padmalatha and A. S. Padmavathamma

SKL Telangana State Horticultural University, College of Horticulture, Rajendranagar, Hyderabad-30 (Telangana), India.

Abstract

In the present investigation efforts were made to study the effect of different embedding media on production of quality dry flowers in carnation cvs. Harvey and Gaudina during the year 2014. Flowers of 6 cm stalk length were embedded in different desiccants *viz.*, sand, sawdust, borax, silica gel and combinations of sand + saw dust (1:1, v/v), sand + borax (1:1, v/v), sand + silica gel (1:1, v/v), sawdust + borax (1:1, v/v), sawdust+ silica gel (1:1, v/v) and borax + silica gel (1:1, v/v) along with control (without embedding) and dried at room temperature in a well ventilated room. There were 22 treatment combinations and replicated thrice. Data were statistically analyzed in Completely Randomized Design with factorial concept. The results showed that among the cultivars, 'Gaudina' recorded maximum dry flower weight (1.55 g) and dry flower diameter (3.86 cm). Cv. Harvey registered significantly maximum percent moisture loss (79.39), minimum time for drying (7.55 days) and maximum sensory score for color (1.80), shape (2.26), texture (2.57), brittleness (2.22) and overall acceptability (2.13). Among the embedding media, drying the flowers in sand recorded maximum dry flower weight (1.95 g), dry flower diameter (4.15 cm) and textural score (3.61). Flowers dried without embedding medium (control) recorded maximum percent moisture loss (83.51). Silica gel embedded flowers took minimum time (3.06 days) for drying. Maximum score for color (2.11), shape (3.73), brittleness (3.13) and overall acceptability (2.58) was recorded with the flowers embedded in borax + silica gel (1:1,v/v) mixture.

Key words : Carnation, dehydration, embedding medium, silica gel, borax, sensory score.

Introduction

The scope of utility and importance of flowers have been realized throughout the world and in this modern age, floriculture has developed into a profitable industry. There is an increasing demand all over the world for the decoration of living and working places with eco-friendly things like fresh foliages and flowers, dried plant parts and dry flowers. Fresh flowers and foliages though exquisite in their beauty are highly expensive. Also, they are perishable and delicate in nature and cannot retain their beauty and fresh look for a long time in spite of using best chemicals for enhancing vase life. Moreover, there is a non-availability of fresh flowers and foliages all round the year in all places (Datta, 2004). In this context, dried and preserved ornamental products offer a wide range of qualities like novelty, longevity, aesthetic properties, flexibility and year round availability. Dried ornamental plant parts are generally less expensive and are sought for their everlasting and attractive appearance. Dried flowers and foliage can be used for making decorative floral segments like wall hangings, landscape calendars, potpourries etc. for various purposes with potpourries being the major segment of drying flower industry valuing at Rs. 55 crores in India alone (Nirmala *et al*., 2008). In the recent floriculture trade, the export of dry flowers from India during 2013-14 was Rs. 363.3 crores (Perinban *et al*., 2014). In India, dry flower industry is mostly concentrated in Tamil Nadu, West Bengal, Andhra Pradesh and Karnataka. Exporting companies at Kolkata in West Bengal, Tuticorin in Tamil Nadu, Mumbai in Maharashtra and Hyderabad in Telangana are earning 10-15 times higher returns than domestic markets. In India, we have never looked into the tremendous export potential of dry flower industry and till date it is the most neglected industry. There is an unlimited prospect in this field and only with sustained efforts, we can make a significant presence in the world market. The growing demand for dry flowers is increasing day by day due to change in purchasing power and living habit of the human being in the world. So, there is a need to tune the techniques of drying of flowers with special reference to the available flora and fauna under the conditions prevailing in India. Carnation (*Dianthus* *caryophyllus* L.) the 'divine flower' or 'flower of the Gods' is one of the most important cut flower of the world, due to its excellent keeping quality, wide range of forms, ability to withstand long distances even after continuous shipping. In India, very little organized research work was done in carnation flowers for production of dry flowers. In dehydration of flowers, embedding is one of the most important processes. The flower and foliage are embedded very carefully in drying material to avoid shrinkage and other morphological changes in the dehydrated materials due to air drying. Hence, an investigation was undertaken to study the performance of various desiccants for embedded drying of carnation flowers.

Materials and Methods

The experiment was carried out at College of Horticulture, Rajendranagar, Hyderabad from August to November, 2014. In the present study, 22 treatment combinations consisting of two carnation cultivars *viz*., Gaudina (red) and Harvey (yellow) and eleven media *viz*., sand, sawdust, borax, silica gel, sand + saw dust (1:1, v/v), sand + borax (1:1, v/v), sand + silica gel (1:1, v/v), sawdust + borax (1:1, v/v), sawdust + silica gel (1:1, v/v), borax + silica gel (1:1, v/v) and control (without embedding) were evaluated in Factorial Completely Randomized Design with three replications. The healthy, disease free and uniform flower stems of carnation cultivars Gaudina and Harvey were harvested at the commercial stage (ray florets 3/4th opened) in the morning hours between 8.00 and 9.00 am. Immediately after harvest, the cut ends of the flower stalks were placed in distilled water and brought to the laboratory of the department. The stem length of the each flower was kept at a uniform length of 6 cm. The leaves present on each cut stem were removed before using them for drying. Plastic containers (14 cm height and 14 cm diameter) with lid were used for filling the embedding medium. About one inch layer of the desiccant was poured into the bottom of container and the flower stems were pushed into the medium. Desiccant was then gently and gradually poured all around and over the flower up to 4 to 5 cm above, so as to fill all the crevices in between the petals without disturbing the shape of flowers. After embedding the flowers in the desiccants, the containers were kept in a well ventilated room for drying at room temperature. After dehydration, the containers were tilted for removing the desiccants over and around the flowers. The dried flowers were picked up by hand, cleaned by inverting them and tapping the stems with fingers slowly and gently. Remaining desiccant was finally removed with the help of fine brush. Observations on flower fresh weight, dry weight, dry flower diameter, per cent moisture loss and time taken to dry were recorded. A panel of five judges assessed the quality parameters *viz*., color, shape, texture, brittleness and overall acceptability by scoring on a five-point scale *i.e.* excellent, very good, good, bad and very bad with the weightage of 3.5-4.0, 2.5-3.4, 1.5-2.4, 0.5-1.4 and 0.0-0.4, respectively. The data were analyzed using factorial CRD (Panse and Sukhatme, 1985).

Results and Discussion

The flowers used for the experiment did not vary with respect to fresh weight, due to uniform flowers used in the experiment. The data pertaining to carnation dry flower weight as influenced by the cultivars and embedding media under room temperature drying (table 1) revealed that the dry flower weight was significantly influenced by the cultivars. Among the cultivars, 'Gaudina' recorded maximum dry flower weight (1.55) compared to the cv. Harvey (1.39). Differences in dry weight of cultivars may be due to varietal character. Embedding media also had significant effect on dry flower weight. Maximum dry flower weight was observed with sand (1.95 g). This may be due to the reason that sand has a large particle size and heavier in weight and thus, absorbs less moisture as well as it is not able to retain moisture for longer duration. Consequently, the moisture is re-absorbed by flowers. Minimum dry flower weight was recorded without embedding (1.27 g). These results are in accordance with Nirmala *et al*. (2008) in carnation and Dilta *et al*. (2014) in rose buds. Among the interactions between cultivars and media on dry flower weight, maximum dry flower weight was recorded with the cv. Gaudina embedded in sand (2.40) followed by sand + silica gel mixture (1.67) with cv. Gaudina, while minimum dry flower weight was recorded with the cv. Harvey without embedding (1.23) and was on par with the cv. Gaudina (1.29) dried without embedding (control).

It is evident from table 2 that the Gaudina recorded significantly maximum dry flower diameter (3.86 cm) over the cv. Harvey (3.39). The maximum dry flower diameter of cv. Gaudina over Harvey may be due to high moisture content of flower. With respect to the embedding media, maximum dry flower diameter was observed with sand (4.15 cm) than the other embedding media. This may be due the fact that sand does not react with water vapour released during the process of drying as in the case of silica gel and borax. It allows the water vapour to escape into the air freely thereby causing minimum loss in size of flowers. Minimum dry flower diameter was recorded when flowers were dried without embedding (2.71 cm).

Table 1 : Effect of embedding media on dry flower weight (g) in carnation cultivars Gaudina and Harvey.

Treatments (T)	Cultivars (C)		Mean
	Gaudina (C_1)	Harvey (C_2)	
T_1 - Sand	2.40	1.49	1.95
T_2 - Saw dust	1.37	1.36	1.36
T_3 - Borax	1.39	1.25	1.32
T_4 - Silica gel	1.52	1.32	1.42
T_5 - Sand + Saw dust (1:1, v/v)	1.47	1.39	1.43
T_6 - Sand + Borax (1:1, v/v)	1.35	1.53	1.44
+T_7 - Sand + Silica gel (1:1, v/v)	1.67	1.45	1.56
T_8 - Saw dust + Borax (1:1, v/v)	1.59	1.38	1.48
T_9 -Saw dust + Silica gel (1:1, v/v)	1.57	1.37	1.46
T_{10} - Borax + Silica gel (1:1, v/v)	1.46	1.45	1.45
T_{11} - Control (without embedding)	1.29	1.23	1.27
Mean	1.55	1.39	

	S.Em±	CD at 5%
Cultivars (C)	0.00	0.02
Treatments (T)	0.02	0.06
Interaction (C × T)	0.03	0.08

Table 2 : Effect of embedding media on dry flower diameter (cm) in carnation cultivars Gaudina and Harvey.

Treatments (T)	Cultivars (C)		Mean
	Gaudina (C_1)	Harvey (C_2)	
T_1- Sand	4.55	3.75	4.15
T_2- Saw dust	3.98	3.27	3.63
T_3- Borax	4.01	3.57	3.79
T_4- Silica gel	3.75	3.20	3.47
T_5- Sand + Saw dust (1:1, v/v)	3.92	3.27	3.60
T_6- Sand + Borax (1:1, v/v)	3.90	3.52	3.71
T_7- Sand + Silica gel (1:1, v/v)	4.04	3.68	3.86
T_8- Saw dust + Borax (1:1, v/v)	3.75	3.55	3.65
T_9- Saw dust + Silica gel (1:1,v/v)	3.91	3.17	3.54
T_{10}- Borax + Silica gel (1:1,v/v)	3.99	3.56	3.77
T_{11}- Control (without embedding)	2.71	2.71	2.71
Mean	3.86	3.39	

	S.Em±	CD at 5%
Cultivars (C)	0.02	0.07
Treatments (T)	0.05	0.16
Interaction (C × T)	0.08	0.23

These results were in line with Rajesh *et al.* (2006) in chrysanthemum and Nirmala *et al.* (2008) in carnation. Among the interactions, flowers of cv. Gaudina embedded in sand recorded significantly maximum dry flower diameter (4.55 cm) and minimum dry flower diameter was recorded with the cv. Gaudina without embedding (2.71 cm) and was on par with cv. Harvey (2.71 cm) dried without embedding (control).

The per cent moisture loss was significantly influenced by cultivars and embedding media (table 3). cv. Harvey recorded maximum per cent moisture loss (79.39) when compared to the cv. Gaudina (75.11). Maximum per cent moisture loss was recorded in flowers dried without embedding (83.51) followed by borax (80.14). Minimum per cent moisture loss was recorded with sand (70.13). With respect to interactions, the cv. Gaudina lost maximum per cent of moisture when dried without embedding medium (85.10) and was on par with cv. Harvey dried in silica gel (82.04). Minimum per cent moisture loss was observed when flowers of cv. Gaudina dried with sand (62.77). The maximum percentage of moisture loss in carnation flowers dried without embedding may be due to direct exposure of flowers to different climatic conditions resulting in rapid moisture loss. These results are in accordance with Dhatt *et al.* (2007) in rose buds.

A perusal of data on the time taken for drying of carnation flowers (table 4) indicated that among the cultivars, 'Harvey' took s least time for drying (7.55 days) than the cv. Gaudina (9.03 days). This might be due to low moisture content of flower and papery structure of flower petals. Variation among the rose cultivars with regard to time taken for drying was also reported by Safeena *et al*. (2006). Significantly least time for drying of flowers was recorded with silica gel (3.06 days) followed by borax + silica gel mixture (4.66 days). Maximum time for drying of flowers was recorded without embedding (13.53 days). The interaction effects of carnation cultivars and embedding media on time taken to dry were found significant. Flowers of *cv.* Harvey embedded in silica gel took minimum time for drying (2.93 days) and was on par with *cv.* Gaudina dried in silica gel (3.20 days). Cv. Gaudina dried without embedding took maximum time (14.57 days) for drying. Drying was much

Table 3 : Effect of embedding media on per cent moisture loss (%) in carnation cultivars Gaudina and Harvey.

Treatments (T)	Cultivars (C)		Mean
	Gaudina (C_1)	Harvey (C_2)	
T_1- Sand	62.77	77.50	70.13
T_2- Saw dust	80.08	78.56	79.32
T_3- Borax	79.76	80.52	80.14
T_4- Silica gel	75.83	82.04	78.94
T_5- Sand + Saw dust (1:1, v/v)	78.84	76.98	77.91
T_6- Sand + Borax (1:1, v/v)	75.13	80.64	77.88
T_7- Sand + Silica gel (1:1, v/v)	68.66	77.84	73.25
T_8- Saw dust + Borax (1:1, v/v)	68.01	80.60	74.31
T_9- Saw dust + Silica gel (1:1, v/v)	72.09	81.33	76.71
T_{10}- Borax + Silica gel (1:1, v/v)	79.89	75.39	77.64
T_{11}- Control (without embedding)	85.10	81.92	83.51
Mean	75.11	79.39	

	S.Em±	CD at 5%
Cultivars (C)	0.40	1.16
Treatments (T)	0.95	2.72
Interaction (C × T)	1.34	3.84

Table 4 : Effect of embedding media on time taken to dry (days) in carnation cultivars Gaudina and Harvey.

Treatments (T)	Cultivars (C)		Mean
	Gaudina (C_1)	Harvey (C_2)	
T_1- Sand	11.00	10.10	10.55
T_2- Saw dust	9.24	8.33	8.79
T_3- Borax	8.47	6.90	7.68
T_4- Silica gel	3.20	2.93	3.06
T_5- Sand + Saw dust (1:1, v/v)	12.58	10.73	11.65
T_6- Sand + Borax (1:1, v/v)	10.48	8.96	9.72
T_7- Sand + Silica gel (1:1, v/v)	6.00	4.39	5.19
T_8- Saw dust + Borax (1:1, v/v)	12.50	10.26	11.38
T_9-Saw dust + Silica gel (1:1, v/v)	5.66	4.28	4.97
T_{10}- Borax + Silica gel (1:1, v/v)	5.66	3.66	4.66
T_{11}- Control (without embedding)	14.57	12.50	13.53
Mean	9.03	7.55	

	S.Em±	CD at 5%
Cultivars (C)	0.05	0.15
Treatments (T)	0.12	0.36
Interaction (C × T)	0.17	0.51

faster with silica gel followed by silica gel and borax mixture. This might be due to strong hygroscopic nature of silica gel and borax. This might also be attributed to the hydrosorbant nature of silica gel which is manufactured from sodium silicate. Silica gel is composed of a vast network of interconnecting microscopic pores, which attract and hold moisture by a phenomenon known as physical adsorption and capillary condensation. Through, this phenomenon acts as a dehydrating agent. These results were in accordance with Singh *et al*. (2004) in zinnia flowers and Safeena *et al*. (2006) in rose. Singh and Dhaduk (2005) reported that silica gel provided quicker results followed by borax due to strong hygroscopic nature of silica and borax.

Colour of dried carnation flowers differed significantly due to cultivars and dessiacants (table 5). Cv. Harvey with yellow colour had retained good colour and received the maximum score of 1.80 when compared to the cv. Gaudina (0.30). Cv. Gaudina (red) lost colour after drying. It might be due to bleaching reaction of flower colour to drying or due to varietal character, dark red becomes black. This result was in confirmation with the finding of Datillo (2001), who opined that brighter the flower longer the colour last. Significantly maximum score for colour was recorded with borax + silica gel mixture (2.11) followed by sand + silica gel mixture (1.65). Least score for colour (0.18) was recorded without embedding. The interaction effect of cultivars and embedding media on colour showed significant differences. Maximum score of 3.63 for colour was recorded with cv. Harvey embedded in borax + silica gel mixture while, the least score for colour (0.10) was recorded when flowers of Gaudina dried without embedding and was found on par with the cv. Gaudina embedded in saw dust + silica gel mixture (0.13). Sadhu (2002) described silica gel embedding as the appropriate method for proper colour retention of helichrysum and statice. Kumari and Peiris (2000) reported that colour retention in rose petals was high when the silica gel desiccant method was used. Singh and Dhaduk (2005) and Safeena *et al*. (2006) have also reported that flowers of chrysanthemum and rose respectively retained best quality when dehydrated by

Table 5 : Effect of embedding media on colour of dried carnation cultivars Gaudina and Harvey as assessed through sensory evaluation.

Treatments (T)	Cultivars (C)		Mean
	Gaudina (C_1)	Harvey (C_2)	
T_1- Sand	0.26	1.33	0.80
T_2- Saw dust	0.23	1.13	0.68
T_3- Borax	0.46	2.80	1.63
T_4- Silica gel	0.40	2.46	1.43
T_5- Sand + Saw dust (1:1, v/v)	0.20	1.30	0.75
T_6- Sand + Borax (1:1, v/v)	0.33	1.60	0.96
T_7- Sand + Silica gel (1:1, v/v)	0.50	2.80	1.65
T_8- Saw dust + Borax (1:1, v/v)	0.16	1.23	0.70
T_9-Saw dust + Silica gel (1:1, v/v)	0.13	1.26	0.70
T_{10}- Borax + Silica gel (1:1, v/v)	0.60	3.63	2.11
T_{11}- Control (without embedding)	0.10	0.26	0.18
Mean	0.30	1.80	

	S.Em±	CD at 5%
Cultivars (C)	0.01	0.03
Treatments (T)	0.03	0.09
Interaction (C × T)	0.04	0.12

Table 6 : Effect of embedding media on shape of dried carnation cultivars Gaudina and Harvey as assessed through sensory evaluation.

Treatments (T)	Cultivars (C)		Mean
	Gaudina (C_1)	Harvey (C_2)	
T_1- Sand	2.30	2.30	2.30
T_2- Saw dust	2.56	2.56	2.56
T_3- Borax	2.76	2.10	2.43
T_4- Silica gel	2.66	2.70	2.68
T_5- Sand + Saw dust (1:1, v/v)	2.26	2.26	2.26
T_6- Sand + Borax (1:1, v/v)	2.33	2.33	2.33
T_7- Sand + Silica gel (1:1, v/v)	1.20	2.66	1.93
T_8- Saw dust + Borax (1:1, v/v)	1.26	2.13	1.70
T_9-Saw dust + Silica gel (1:1, v/v)	1.53	1.53	1.53
T_{10}- Borax + Silica gel (1:1, v/v)	3.60	3.86	3.73
T_{11}- Control (without embedding)	0.23	0.43	0.33
Mean	2.06	2.26	

	S.Em±	CD at 5%
Cultivars (C)	0.01	0.04
Treatments (T)	0.03	0.11
Interaction (C × T)	0.05	0.15

embedding in silica gel for colour retention.

The sensory score for shape as influenced by the cultivars and embedding media under room temperature drying is presented in table 6. Among the cultivars, Harvey recorded significantly maximum score for shape (2.26) than the cv. Gaudina (2.06). These results were in line with the findings of Joykumar (1997) and Safeena *et al*. (2006), who reported that flowers of rose and China aster and chrysanthemum retained best quality when dehydrated by embedding in silica gel for shape retention. Significant differences were observed among the embedding media on flower shape. Borax + silica gel mixture recorded maximum score (3.73) followed by silica gel (2.68). Aravinda and Jayanthi (2004) reported that silica gel embedded flowers retained their shape even after drying. Singh *et al*. (2004) reported that mechanical support provided by the media throughout the drying process ensured well maintained flower shape in the flowers. Dhatt *et al*. (2007) reported that Christan Dior and Gold Medal cultivars of rose embedded in silica gel exhibited the highest score for shape retention. Least score for shape was noticed with the flowers dried without embedding (0.33). It might be due to variations in the humidity level of the microclimatic conditions resulting in uneven drying and cracking leading to loss of shape. These results were in accordance with Kumari and Peiris (2000) in rose. With respect to the interactions, maximum score for shape was recorded with cv. Harvey dried with borax + silica gel mixture (3.86), while the least score for shape (0.23) was recorded when flowers of cv. Gaudina were dried without embedding.

Significant differences were observed due to cultivars and embedding media with respect to texture of dried carnation flowers (table 7). The cv. Harvey recorded maximum score for texture (2.57). The least score was noticed in cv. Gaudina (2.48). The variation among the cultivars may be owed to the characteristic feature of the cultivar. Maximum textural score was observed with sand (3.61) followed by borax + silica gel mixture (3.20). Least score for texture (1.05) was recorded in the flowers dried without embedding. Texture was significantly better in sand dried flowers of cv. Harvey (3.70), which was

Table 7 : Effect of embedding media on texture of dried carnation cultivars Gaudina and Harvey as assessed through sensory evaluation.

Treatments (T)	Cultivars (C) Gaudina (C_1)	Harvey (C_2)	Mean
T_1- Sand	3.50	3.70	3.61
T_2- Saw dust	1.90	2.00	1.95
T_3- Borax	2.33	2.43	2.38
T_4- Silica gel	2.96	2.86	2.91
T_5- Sand + Saw dust (1:1, v/v)	2.73	2.46	2.60
T_6- Sand + Borax (1:1, v/v)	2.60	2.60	2.60
T_7- Sand + Silica gel (1:1, v/v)	3.10	3.00	3.05
T_8- Saw dust + Borax (1:1, V/V)	2.16	2.03	2.10
T_9-Saw dust + Silica gel (1:1, v/v)	2.53	2.16	2.35
T_{10}- Borax + Silica gel (1:1, v/v)	3.20	3.20	3.20
T_{11}- Control (without embedding)	0.33	1.76	1.05
Mean	2.48	2.57	

	S.Em±	CD at 5%
Cultivars (C)	0.02	0.06
Treatments (T)	0.05	0.14
Interactions (C × T)	0.07	0.20

Table 8 : Effect of embedding media on brittleness of dried carnation cultivars Gaudina and Harvey as assessed through sensory evaluation.

Treatments (T)	Cultivars (C) Gaudina (C_1)	Harvey (C_2)	Mean
T_1- Sand	2.10	2.60	2.35
T_2- Saw dust	2.30	2.53	2.41
T_3- Borax	2.60	2.70	2.65
T_4- Silica gel	1.70	2.83	2.26
T_5- Sand + Saw dust (1:1, v/v)	2.10	1.46	1.78
T_6- Sand + Borax (1:1, v/v)	2.16	1.33	1.75
T_7- Sand + Silica gel (1:1, v/v)	2.50	2.90	2.70
T_8- Saw dust + Borax (1:1, v/v)	2.03	2.10	2.06
T_9-Saw dust + Silica gel (1:1, v/v)	2.16	1.93	2.05
T_{10}- Borax + Silica gel (1:1, v/v)	2.63	3.63	3.13
T_{11}- Control (without embedding)	0.13	0.43	0.28
Mean	2.03	2.22	

	S.Em±	CD at 5%
Cultivars (C)	0.01	0.05
Treatments (T)	0.04	0.12
Interaction (CXT)	0.06	0.17

found on par with sand dried flowers of cv. Gaudina (3.50), while least score for texture was noticed when flowers of cv. Gaudina dried without embedding media (0.33). These results were in accordance with Nirmala *et al*. (2008), who reported that maximum textural score was recorded with sand dried flowers of carnation. Singh *et al*. (2004) reported that drying with sand provided smooth petal texture in zinnia.

With respect to the sensory score on brittleness of the dried flowers (table 8), it was noticed that 'Harvey' recorded maximum score for brittleness (2.22) when compared to the cv. Gaudina (2.03). Borax + silica gel mixture (3.13) followed by sand + silica gel mixture (2.70) had better score for flower brittleness. Least score of 0.28 was recorded without embedding medium. Significant differences were observed with respect to brittleness due to interaction of cultivars and embedding media. Maximum score for brittleness was recorded when flowers of cv. Harvey dried with borax + silica gel mixture (3.63) followed by sand + silica gel mixture (2.90). Least score (0.13) was recorded in the flowers of cv. Gaudina dried without any embedding medium. From these results, it could be stated that the differences in brittleness of the cultivars might be due to varietal character. The higher score for brittleness recorded with borax + silica gel mixture could be attributed to the quick removal of moisture with this combination in short time with least effect on texture of flowers.

The data from table 9 revealed that the yellow coloured cultivar Harvey recorded maximum score for overall acceptability (2.13) over the cv. Gaudina (0.72). Significant differences were observed on overall acceptability score due to different embedding media. Maximum score for overall acceptability was recorded with borax + silica gel mixture (2.58) followed by sand + silica gel mixture (2.13). Least score (0.21) was recorded in flowers dried without embedding. With respect to interactions, he flowers of the cv. Harvey dried in borax + silica gel mixture recorded the maximum score of 3.83 for overall acceptability followed by sand + silica gel mixture (3.03), while least score of 0.20 was recorded with the flowers of cv. Gaudina dried without embedding

Table 9 : Effect of embedding media on overall acceptability of dried carnation cultivars Gaudina and Harvey as assessed through sensory evaluation.

Treatments (T)	Cultivars (C)		Mean
	Gaudina (C_1)	Harvey (C_2)	
T_1- Sand	0.73	2.26	1.50
T_2- Saw dust	0.60	2.00	1.30
T_3- Borax	1.10	2.90	2.00
T_4- Silica gel	0.96	2.46	1.71
T_5- Sand + Saw dust (1:1, v/v)	0.53	1.96	1.25
T_6- Sand + Borax (1:1, v/v)	0.40	1.63	1.01
T_7- Sand + Silica gel (1:1, v/v)	1.23	3.03	2.13
T_8- Saw dust + Borax (1:1, v/v)	0.36	1.53	0.95
T_9-Saw dust + Silica gel (1:1, v/v)	0.50	1.66	1.08
T_{10}- Borax + Silica gel (1:1, v/v)	1.33	3.83	2.58
T_{11}- Control (without embedding)	0.20	0.23	0.21
Mean	0.72	2.13	

	S.Em±	CD at 5%
Cultivars (C)	0.01	0.03
Treatments (T)	0.03	0.09
Interaction (C × T)	0.04	0.12

and was on par with cv. Harvey flowers dried without embedding (0.23). Nirmala *et al*. (2008) reported that overall acceptability was highest when carnation flowers were embedded in silica gel. Nair and Singh (2011) reported that chrysanthemum flowers embedded in silica gel scored the maximum points for good appearance. The highest score on overall acceptability with borax + silica gel mixture might be ascribed to the beneficial effect of silica gel in maintaining the original colour and shape of carnation flowers in combination with borax as shown in tables 5 and 6.

Thus, it can be concluded that the cv. Harvey performed better than the cv. Gaudina with respect to the sensory attributes. Among the various desiccants, borax + silica gel (1:1 v/v) mixture was best for embedded drying of carnation flowers at room temperature.

References

Aravinda, K. and R. Jayanthi (2004). Standardization of drying techniques for chrysanthemum (*Dendranthema grandiflora* cv. Button Type Local) flowers. *J. Orn. Hort*., **7** : 370-375.

Datillo, S. (2001). Preserving roses by drying. *http://www.ars.org/drying.html.*

Datta, S. K. (2004). Dehydration of flowers : A new diversified product for floriculture industry emerging trends in Ornamental Horticulture. *Ind. Soc. Orn. Hort*., 157-161.

Dhatt, K. K., K. Singh and K. Ramesh (2007). Studies on methods of dehydration of rose buds. *J. Orn. Hort*., **10** : 264-267.

Dilta, B. S., T. B. Behera, Y. C. Gupta, R. B. Bhalla and P. Sharma (2014). Effect of embedding media, temperature and durations on hot air oven drying of rose (*Rosa hybrida* L.) *cv.* First Red. *Ind. J. Applied Res*., **4** : 233-239.

Joykumar, N. (1997). Studies on the drying characteristics of some important flowers. *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences.

Kumari, D. L. C. and S. E. Peiris (2000). Preliminary investigation of preservation methods to produce dried flowers of rose and statice. *Tropical Agric.Res*., **12** : 416-422.

Nair, B. and K. P. Singh (2011). Aesthetic quality of chrysanthemum (*Dendranthema grandiflora* T.) flowers as affected by the desiccants. *J. Agrocrop Sci*., **2** : 11-14.

Nirmala, A., R. Chandrasekhar, M. Padma and M. Raj Kumar (2008). Standardization of drying techniques of Carnation (*Dianthus caryophyllus*). *J. Orn. Hort*., **11** : 168-172.

Panse, V. G. and P. V. Sukhatme (1985). *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research, New Delhi.

Perinban, S., J. Majumder, B. Singh, T. Rai and R. Kumar (2014). *Dried flowers: a new paradigm in Floriculture*. http:/www.krishisewa.com/cms/articles/pht/394-dried-flowers.html.

Rajesh, B. M., S. R. Dhiman and K. S. Thakur (2006). Standardization of drying techniques of chrysanthemum (*Dendranthema garndiflorum* Tzvelev.). *J. Orn. Hort*., **9** : 159-163.

Sadhu, A. (2002). Studies on the dehydration of winter annuals. *M.Sc. (Floriculture) Thesis* submitted to Punjab Agricultural University, Ludhiana-1410004, Punjab, India.

Safeena, S. A., V. S. Patil and B. Hemla Naik (2006). Response of drying in hot air oven on quality of rose flowers. *J. Orn. Hort*., **9** : 114-117.

Singh, A., B. K. Dhaduk and R. R. Singh (2004). Effect of different temperatures and embedding media on flower dehydration of zinnia. *Ind. J. Hort. Sci*., **61** : 249-252.

Singh, A. and B. K. Dhaduk (2005). Effect of dehydration techniques in some selected flowers. *J. Orn. Hort*., **8** : 155-156.