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Effect of different embedding media on quality of dry flower in cut flowers (Carnation, Rose, Chrysanthemum)

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Abstract
The present study was carried out in the laboratory of the Department of Floriculture and Landscape Architecture, College of Horticulture, Dr. Y.S.H.R.U., Anantharajupeta, Kadapa (Dist), Andhra Pradesh during February 2022 with 3 different cut flowers *i.e.*, Carnation, (F_1) Rose (F_2) and Chrysanthemum (F_3). This experiment was laid out in Factorial CRD with a factorial concept and comprised of 3 replications. This study is conducted mainly to show the effect of different embedding media *viz.*, sand (M_1), silica gel (M_2), activated alumina (M_3), diatomaceous earth (M_4) and their treatment combinations like sand+silicagel (M_5), sand+activatedalumina (M_6), sand+diatomaceous earth (M_7), silica gel+activated alumina (M_8), silica gel + diatomaceous earth (M_9), activated alumina+ diatomaceous earth (M_{10}) on quality of dry flowers along with control (M_{11}). The main aim of this study is to select 3 best media for drying of flowers. The results showed significant difference among the flowers in parameters like dry weight, moisture loss per cent, flower diameter and time taken for drying.
Flowers embedded in M_2 (4days), M_3(3 days) recorded minimum drying time. Treatments M_2, M_8 and M_9 recorded minimum dry weight (0.987 g, 1.054 g, 0.992 g) and least flower diameter (1.244 cm, 1.378 cm, 1.455 cm), respectively. Maximum moisture loss per cent recorded in (M_8-77.8%, M_2-79.7%, M_9- 73.5%, M_{10}-77.1%.) Qualitative parameters also recorded best results by using M_2, M_8 and M_9 media.

Keywords: Carnation, rose, chrysanthemum, embedding media, silica gel, activated alumina, diatomaceous earth

Introduction
The floriculture industry is rapidly expanding all over the world. It has enormous export potential in addition to domestic use. The sale of cut flowers is an important part of the floriculture industry. Despite the use of the most advanced chemicals to improve keeping quality and extend vase life, cut flowers have a relatively short shelf life. Fresh flower substitutes are being sought. Dried flowers are a low-cost and environmentally friendly solution to these efforts. Dry flowers account for 71% of India's exports, with the majority going to the United States, Japan, Australia, Russia, and Europe (Sangeetha *et al*., 2014) [6].
Flowers are the most beautiful feature of nature that has ever captivated man, and they play an important role in every celebration of human existence. Floral displays make people look better, more capable, and more self-assured. The global demand for eco-friendly home and workplace decors, such as fresh leaves, flowers, dried plant parts, and dry flowers, is increasing.
The majority of flowers are fresh; nevertheless, their acceptable state is only maintained for a short time due to their limited shelf life. Flower drying techniques are consequently critical in preserving their look for a few days. Dried flowers have a huge market potential to replace fresh flowers.
Hot air oven drying, microwave drying, desiccant drying, press drying, and air drying are the most prevalent flower drying procedures.
The carnation (*D. caryophyllus*), sometimes known as the "flower of the Gods" or the "divine flower," is one of the world's most important cut flowers due to its outstanding keeping characteristics, a broad array of shapes, and adaptability across long distances even after continuous shipment. Carnation flowers are becoming more popular as cut flowers due to their brightness both fresh and dry. (Nagri and Singh, 2011) [4].
The rose is known as the "Queen of Flowers'' and is considered to be one of nature's most beautiful creations. Rose blossoms exist in a broad range, each with its unique form, size, and colour. As a result, fresh roses are not widely accessible throughout the year.

Rose blossoms can be dried, kept, and treated in this condition to keep their beauty and value forever.

The chrysanthemum, often known as the "Queen of the East" or "Glory of the East," is a commercial flower crop cultivated in numerous countries. In terms of flower trade value on the worldwide market, it ranks second only to roses. It is Japan's national flower. Chrysanthemums (*Dendranthema grandiflorum*) are particularly popular as a crop of lovely flowers. It is valuable as a potted plant and is produced commercially in various countries as a cut flower crop. It is widely grown in India's open fields for its loose blossoms. It comes in a range of colours, shapes, and sizes. This flower has a vase life of around 10 to 15 days, but if kept dry, it may stay much longer while remaining lovely. Dried chrysanthemum flowers are in high demand on the global market. The present study on the effect of different embedding media on production quality of dry flower in cut flowers (Carnation, Rose, Chrysanthemum) was carried out with the objective of evaluating to find out suitable alternative low-cost desiccant for drying of cut flowers. Therefore, the present investigation was undertaken to evaluate quantitative parameters.

Materials and Methods:

The present experiment was carried out in the laboratory of the Department of Floriculture and Landscape Architecture, College of Horticulture, Dr. Y.S.H.R.U., Anantharajupeta, Kadapa (Dist), Andhra Pradesh (state) during the period from February 2022 to May 2022. The experiment was carried out with the different flowers of carnation (red) Rose (yellow) Chrysanthemum (Green) the flowers are collected from flower markets of Tirupathi and embedding media used are Sand, Silica gel, Activated alumina, Diatomaceous earth and their treatment combination mixtures. In the present study, 11 treatment combinations consisting of three different cut flowers *viz*., Carnation (red), Rose (Yellow) and Chrysanthemum (Green), were evaluated in Factorial Completely Randomized Design with three replications. For air drying under shade, the flowers were embedded in all different media using glassware and kept in a warm, dry room with good air circulation. The dried flowers were taken up by hand, cleaned by flipping them over, and then given a slow, gentle tap with the fingertips. Using a fine brush, the remaining desiccant was eventually removed. The data pertaining to different parameters like flower dry weight, dry flower diameter, and per cent moisture loss were recorded.

Results and Discussion

Dry weight of cut flowers (g)

The flowers used for the experiment vary with respect to fresh weight. The data pertaining to dry flower weight as influenced by the different flowers and embedding media is presented in Table 1. Among the three flowers, Rose (F_2) flowers recorded a maximum dry weight (1.68 g), while minimum dry weight (0.40 g) was recorded in Chrysanthemum flowers (F_3). Among different embedding media, it was found to be non-significant. With respect to interactions significantly maximum dry flower weight (2.58 g) was recorded when Rose flowers embedded in diatomaceous earth (M_4) which was on par with when rose flowers embedded in sand+diatomaceous earth mixture (M_7) (2.49 g) and rose flowers embedded in sand + silica gel mixture (M_5) (2.15 g). Minimum dry flower weight (0.26 g) was recorded when chrysanthemum flowers embedded in sand + silica gel mixture (M_5) which was on par with the chrysanthemum flowers embedded in all media.

Naeve (1996) [3] reported that silica gel was the fastest acting desiccant.

Kumari and Peiris (2000) [2] reported that in drying process with silica gel water absorption was even as flower petals were evenly surrounded by silica gel beads.

Flower diameter (cm)

From the data presented in Table 2 and graphical depiction of figure 2, it was evident that changes in diameter differed significantly due to different flowers and embedding media used for this experiment.

The data in the table clearly revealed that change in diameter differed significantly. Among the three different flowers, Rose flowers (F_2) has significantly recorded maximum dry flower diameter (2.00 cm), while minimum flower diameter (1.34 cm) was observed in Chrysanthemum flowers (F_3) which was on par with F_1 (1.43 cm).

Among the media used for drying of cut flowers, maximum change in flower diameter was recorded with Activated alumina + Diatomaceous Earth (M_{10}) (1.83) which was on par with Sand + Silica gel (M_5) (1.81 cm), followed by Activated alumina (M_3) (1.76 cm), Diatomaceous Earth (M_4) (1.745cm) and Sand (M_1) (1.68 cm). Minimum flower diameter (1.24 cm) was observed with Silica gel (M_2) which was on par with Silica gel+Activated alumina (M_8) (1.37 cm) and Silica gel+ Diatomaceous earth (M_9) (1.45cm).

The interaction between flowers and embedding media on flower diameter has been found to be significant. Maximum dry flower diameter (2.50 cm) was recorded when Rose flowers (F_2) embedded in Sand which was on par with rose flowers embedded in Sand+ Silica gel (2.46 cm), Activated alumina (2.16 cm), Diatomaceous earth (2.16 cm), Sand+Diatomaceous earth (2.167cm) and also when flower are not embedded in any media (control) (2.20 cm).

These result findings were similar to the research outcome of Yadlod *et al.*, (2016) [7].

Moisture loss percent (%)

The data recorded on the effect of different embedding media on moisture loss per cent has been found to be significant which is presented in Table 3.

Among the three flowers, Rose flowers (F_2) has significantly recorded maximum moisture loss per cent (78.2%) and the minimum per cent moisture loss was observed in Chrysanthemum flowers (F_3) (73.1%).

Embedding media showed a significant effect on moisture loss per cent, silica gel (M2) has recorded maximum moisture loss per cent (79.7%) which stood at a par with activated alumina (79.2%), silica gel + activated alumina (M8) (77.8) , sand + activated alumina (77.4) and sand +silica gel (77.3) while, minimum loss in moisture was observed with control (M11) (65.8%).

Among the interaction between flowers and embedding media, rose flowers embedded with silica gel+ diatomaceous earth had significantly recorded maximum moisture loss per cent F2M9 (87.6%) which was comparable with rose flowers embedded in activated alumina (M3) (86.4%), rose flowers dried with silica gel (86.3%),silica gel + activated alumina (M8) (86.2%), carnation flowers embedded in diatomaceous earth (M4) (82.2%), rose flowers embedded in sand + activated alumina (81.1%), followed by F_1M_4 (82.2%), F_3M_3 (81.2%), F_1M_5 (81.2), F_1M_{10} (81.1%), F_1M_7 (80.4%). Minimum moisture loss per cent was observed in carnation flowers (control) (50.1%). Norman Winter (1998) [5] reported that moisture was absorbed by silica gel from the flowers quickly compared to other media. Minimum time taken for drying of the flowers with silica gel as embedding medium might also be due to the quick dehydration action of silica gel.

Duration of drying

The time taken for drying of carnation flowers was significantly influenced by the embedding media and depicted in fig 4. Among the different embedding media, significantly least time for drying of flowers was recorded with silica gel (3 days) followed by activated alumina (4 days). Maximum time for drying of flowers was recorded without embedding media and in sand drying (10 days).

Rose flowers embedded in activated alumina and its combination with silica gel took minimum time for drying (6 days) and was on par with silica gel (5 days). Flowers dried without embedding and sand drying took maximum time (11 days) for drying.

Chrysanthemum flowers embedded in silica gel and their combination treatments took minimum time for drying (4 days). Flowers dried without embedding and sand drying took maximum time (7 days) for drying.

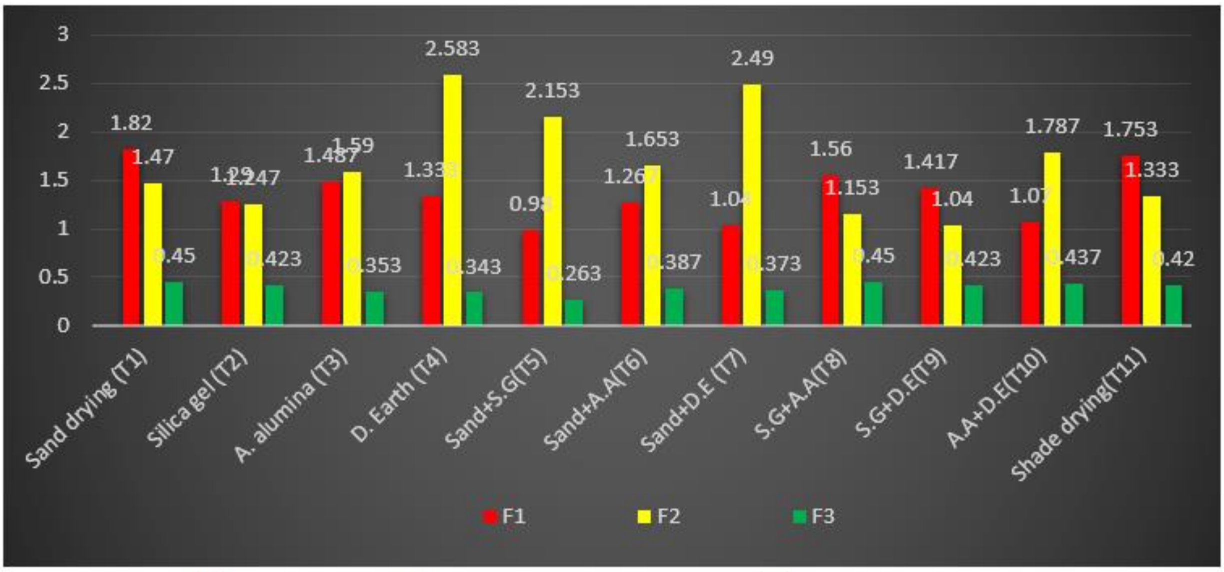
The observations from the table 4 revealed that minimum time for drying was recorded with flowers of Carnation, Rose when they are embedded in silica gel and activated alumina and in Chrysanthemun embedded in silica gel and their combination treatments took minimum time due to its high moisture absorbing capacity. Drying was much faster with silica gel followed by silica gel and alumina mixture. This might be due to strong hygroscopic nature of silica gel. 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.

Time taken for drying that removes the moisture from flowers was judged by the quantitative and qualitative parameters. Flowers embedded in silica gel took minimum time of 3-5 days for complete drying. Difference in the time taken for drying of flowers might be due to nature of desiccants.

These results were in line with the findings of Gill *et al.* (2002) [1].

Table 1: Effect of different embedding media on dry flower weight (g) in cut flowers

Treatments	F1	F2	F3	Mean
Sand drying (M_1)	1.82	1.47	0.45	1.25
Silica gel (M_2)	1.29	1.24	0.42	0.98
Activated alumina (M_3)	1.48	1.59	0.35	1.14
Diatomaceous Earth (M_4)	1.33	2.58	0.34	1.41
Sand+Silica gel (M_5)	0.98	2.15	0.26	1.13
Sand+Activated alumina (M_6)	1.27	1.65	0.39	1.10
Sand+Diatomaceous earth (M_7)	1.03	2.49	0.37	1.30
Silica gel+Activated alumina (M_8)	1.56	1.15	0.45	1.05
Silica gel+ Diatomaceous earth (M_9)	1.41	1.04	0.52	0.99
Activated alumina+ Diatomaceous Earth (M_{10})	1.07	1.79	0.43	1.09
Shade drying (M_{11})	1.75	1.33	0.42	1.16
Mean	1.36	1.68	0.40	
Factors	F	M	FXT	
S.E. (m)	0.058	0.11	0.193	
C.D.	0.164	N/A	0.545	



F1- Carnation F2- Rose F3 -Chrysanthemum

Fig 1: Mean values of different embedding media on dry flower weight of different flowers.

Table 2: Effect of different embedding media on flower diameter (cm) reduction (cm) before placing flowers in media and after drying of flowers.

	F_1		F_2		F_3	
Treatments	**Before**	**After**	**Before**	**After**	**Before**	**After**
Sand drying (M_1)	4.86	4.00	4.00	1.50	2.50	0.80
Silica gel (M_2)	3.20	1.90	4.50	3.27	2.35	0.99
Activated alumina (M_3)	3.70	1.67	4.26	2.10	2.73	1.63
Diatomaceous Earth (M_4)	4.00	2.30	4.30	2.14	2.90	1.54
Sand+Silica gel(M_5)	3.50	2.00	4.10	1.64	2.50	1.04
Sand+Activated alumina(M_6)	3.90	2.47	3.80	2.14	2.70	1.04
Sand+Diatomaceous earth (M_7)	3.00	1.80	3.60	1.44	2.33	0.60
Silica gel+Activated alumina(M_8)	4.00	2.80	3.70	2.07	2.63	1.33
Silica gel+ Diatomaceous earth (M_9)	3.70	2.37	3.90	1.97	2.40	1.30
Activated alumina+ Diatomaceous Earth (M_{10})	3.5	1.47	4.00	2.04	2.88	1.38
Shade drying(M_{11}) (Control)	3.80	2.47	4.20	2.00	3.00	1.94

Table 3: Effect of different embedding media on flower diameter reduction (cm) in cut flowers.

Treatments	**F1**	**F2**	**F3**	**Mean**
Sand drying (M_1)	0.86	2.50	1.70	1.68
Silica gel (M_2)	1.13	1.23	1.36	1.24
Activated alumina (M_3)	2.03	2.16	1.10	1.76
Diatomaceous Earth (M_4)	1.70	2.16	1.36	1.74
Sand+Silica gel (M_5)	1.50	2.46	1.46	1.81
Sand+Activated alumina (M_6)	1.43	1.66	1.66	1.58
Sand+Diatomaceous earth (M_7)	1.20	2.16	1.13	1.50
Silica gel+Activated alumina (M_8)	1.20	1.63	1.30	1.37
Silica gel+ Diatomaceous earth (M_9)	1.33	1.93	1.10	1.45
Activated alumina+ Diatomaceous Earth (M_{10})	2.03	1.96	1.50	1.83
Shade drying (M_{11})	1.33	2.20	1.06	1.53
Mean	1.43	2.00	1.34	
Factors	F	M	FXT	
S.E. (m)	0.045	0.086	0.149	
C.D.	0.127	0.243	0.421	

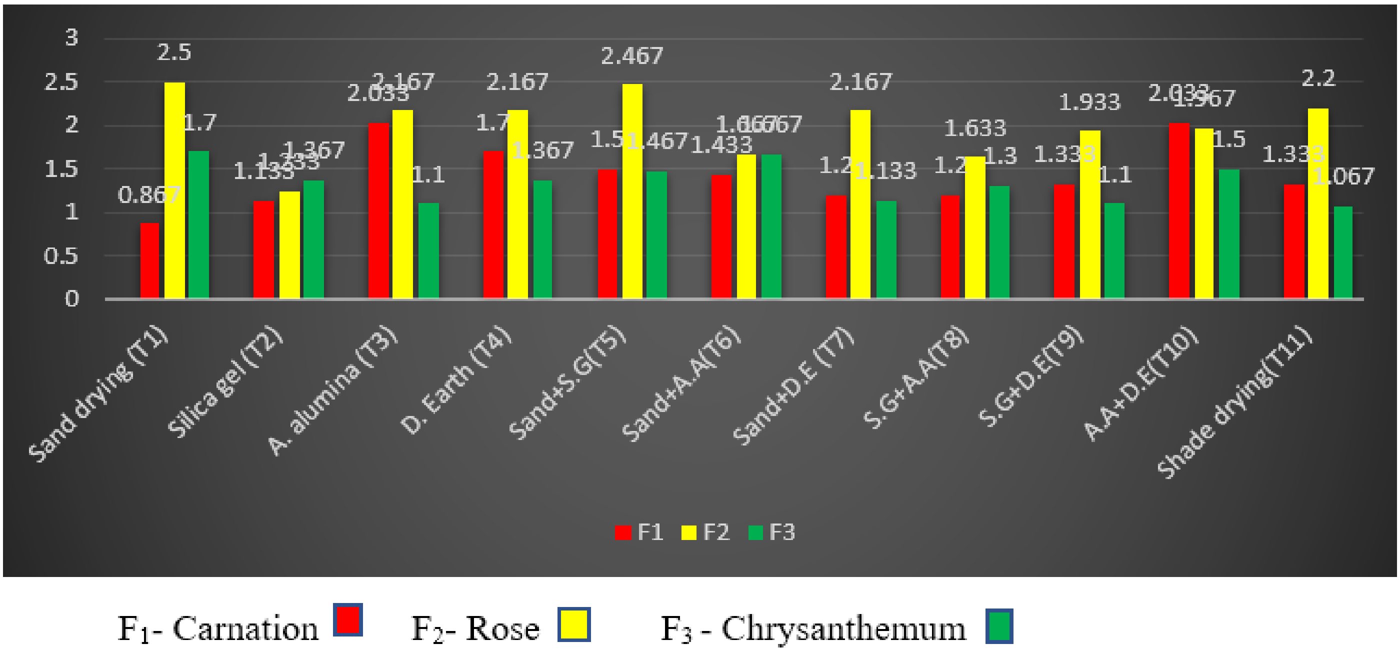
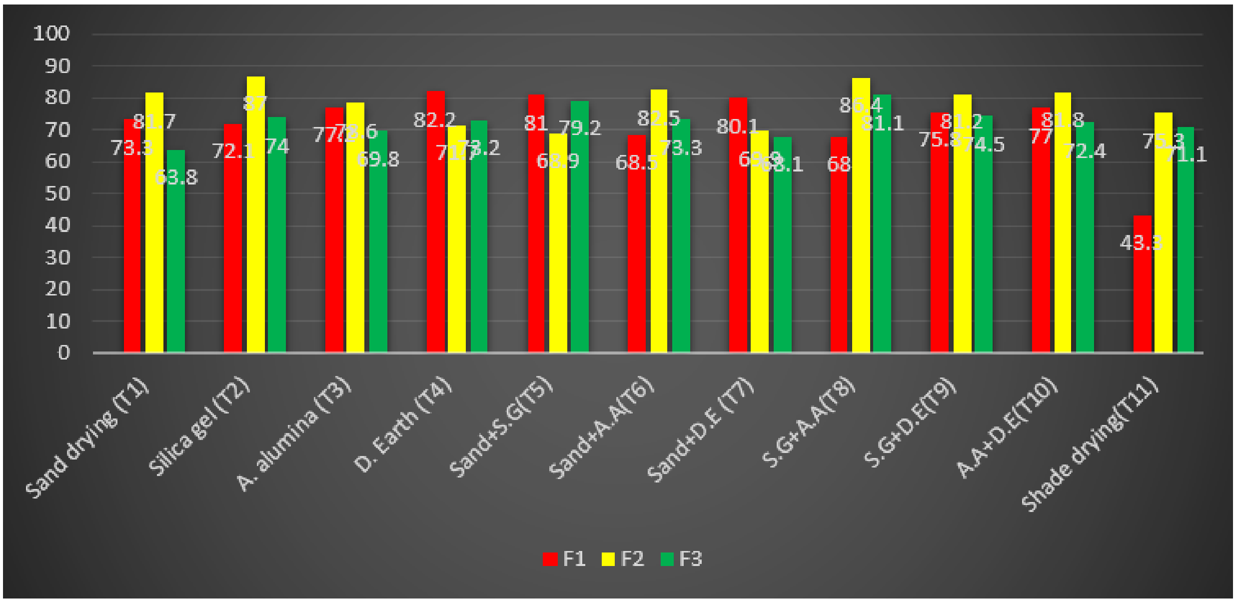


Fig 2: Mean values of different embedding media on flower diameter reduction of different flowers.

Table 4: Effect of different embedding media on moisture loss per cent (%) in cut flowers

Treatments	**F1**	**F2**	**F3**	**Mean**
Sand drying (M_1)	66.0	73.0	68.9	69.3
Silica gel (M_2)	76.8	86.3	76.1	79.7
Activated alumina (M_3)	69.9	86.4	81.2	79.2
Diatomaceous Earth (M_4)	82.2	70.8	73.8	75.6
Sand+Silica gel(M_5)	81.2	69.8	80.8	77.3
Sand+Activated alumina(M_6)	76.6	81.1	74.5	77.4
Sand+Diatomaceous earth (M_7)	80.4	69.6	68.3	72.8
Silica gel+Activated alumina(M_8)	73.1	86.2	74.1	77.8
Silica gel+ Diatomaceous earth (M_9)	70.5	87.6	62.5	73.5
Activated alumina+ Diatomaceous Earth (M_{10})	81.1	74.4	71.8	75.8
Shade drying (M_{11})	50.1	75.4	72.0	65.8
Mean	73.4	78.2	73.1	74.9
Factors	F	M	F×M	
S.E. (m)	1.497	2.86	4.966	
C.D	4.237	8.114	14.053	



F_1- Carnation F_2- Rose F_3 -Chrysanthemum

Fig 3: Mean values of different embedding media on moisture loss per cent of different flowers.

Table 5: Effect of embedding media on duration of drying (days) in cut flowers.

	Drying time (Days)			
Treatments	**F_1**	**F_2**	**F_3**	**Mean**
Sand drying (M_1)	9	11	7	9.00
Silica gel (M_2)	3	6	4	4.33
Activated alumina (M_3)	4	5	5	4.66
Diatomaceous Earth (M_4)	7	7	5	6.33
Sand+Silica gel(M_5)	6	8	4	6.00
Sand+Activated alumina(M_6)	8	9	5	7.33
Sand+Diatomaceous earth (M_7)	10	10	5	8.33
Silica gel+Activated alumina(M_8)	6	5	4	5.00
Silica gel+ Diatomaceous earth (M_9)	5	7	4	5.33
Activated alumina+ Diatomaceous Earth (M_{10})	7	7	5	6.33
Shade drying(M_{11}) (Control)	9	11	7	9.00
Mean	6.72	7.81	5.00	
Factors	F	M	F×M	
$SE_m(\pm)$	0.030	0.057	0.099	
C.D (5%)	0.084	0.162	0.280	

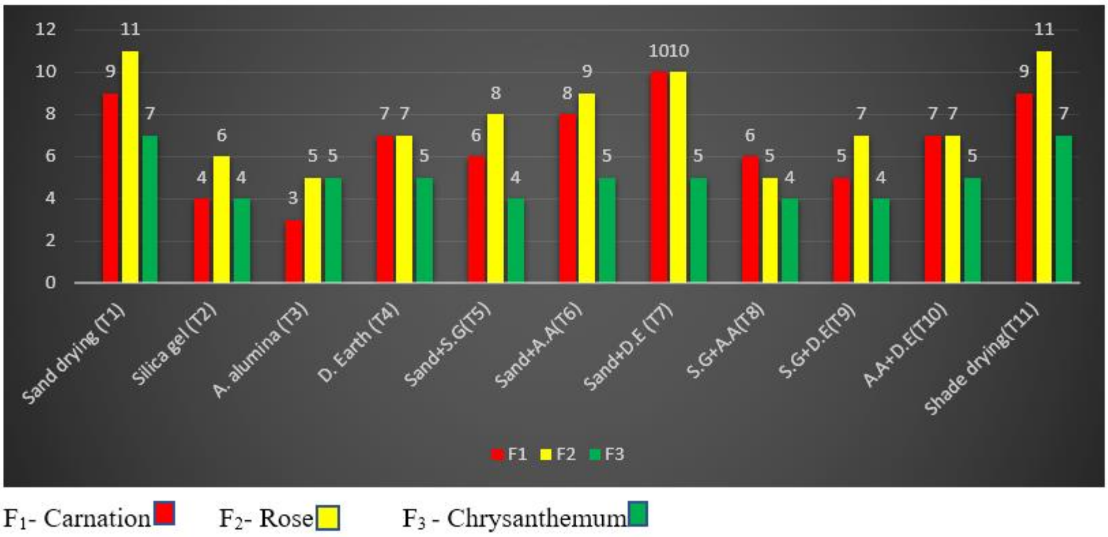


Fig 4: Effect of different embedding media on duration of drying for different flowers.

Conclusion

From the present study, it could be concluded that the cut flowers like Carnation, Rose and Chrysanthemum (F_1, F_2 and F_3) embedded with silica gel (M_2) and silica gel mixtures like Silica Gel + Activated alumina (M_8) and Silica Gel + Diatomaceous earth (M_9) as the embedding medium is best for production of quality dry flowers in cut flowers.

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