Studies on Effect of Different Substrates of Embedded Drying on Chrysanthemum (*Chrysanthemum morifolium* Ramat.)

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Abstract:

A series of studies were conducted to determine the most effective desiccants for the embedded drying process of chrysanthemum flowers (*Chrysanthemum morifolium* Ramat.), aiming to enhance their display quality. The experiment followed a factorial completely randomized design, considering five different desiccants: silica gel, borax, alum powder, river sand, and sawdust. Additionally, four drying temperatures were tested, namely room temperature (21°C), 40°C, 45°C, and 50°C. The results indicated that the treatment using silica gel as the embedded medium at 50°C exhibited the maximum reduction in flower weight (5.78 g). Conversely, the treatment with river sand as the embedded medium at 45°C showed the minimum reduction in flower weight (1.97 g). As for flower diameter reduction, the treatment involving sawdust as the embedded medium at 45°C resulted in the maximum reduction (1.60 cm), while the treatments utilizing alum powder as the embedded medium at 40°C (0.81 cm) and river sand as the embedded medium at room temperature (0.87 cm) displayed the minimum diameter reduction. Regarding flower perimeter reduction, the treatment using borax as the embedded medium at 50°C recorded the highest reduction (2.78 cm), whereas the treatments involving alum powder as the embedded medium at 40°C (1.67 cm) and river sand as the embedded medium at room temperature (1.67 cm) exhibited the least perimeter reduction. Among all the treatments, embedded drying with silica gel at 45°C yielded the best overall results in terms of drying and appearance of the chrysanthemum flowers.

Keywords: Dehydration, dry flowers, silica gel, *chrysanthemum morifolium*, saw dust.

1.Introduction:

Flowers displays improve composition skills and promote self-confidence, according to a study titled "The Effect of Floral Displays on Human Emotions" [1]. Flowers are exquisitely beautiful, yet their beauty is temporary.As a result, flower-dehydration technology is the finest option for extending the life of flowers and allowing people to appreciate their beauty for months or years. The process of flower drying plays a significant role in enhancing the quality and value of flowers after they are harvested. It involves reducing the moisture content of flowers to a point where biochemical changes are minimized while preserving the integrity of cell structure, pigment levels, and the overall shape of the flower [2].

According to the latest data available from the United Nations Comtrade database, the global export value of dried flowers was $325.28 million in 2019, with the top five exporting countries being the Netherlands, France, Germany, Belgium, and the United States [3]. In terms of import value, the United States, Japan, the United Kingdom, Germany, and France were the top five importing countries in 2019, with a total import value of $360.78 million [3]. The American market receives the highest quantity of dried flowers from the Netherlands, with Columbia, Mexico, India, and Israel following in order. Australia has shown an increasing presence as a dry flower exporter, with Japan, Germany, and the United States of America serving as their top markets in recent years [4]. The last few decades have seen a rise in the demand for dry flowers, creating enormous possibilities for Indian entrepreneurs to enter the international floriculture market [5]. The largest category, which accounts for 70% of all Indian exports of floriculture products, is dried flowers and plant parts [6]. Nonetheless, our nation only accounts for 5% of the global dried flower market [7]. The dry flower industry has seen significant growth in recent years in Maharashtra, Karnataka, Andhra Pradesh, Hyderabad, and Kolkata, which have emerged as major players in India. This sector has witnessed an annual growth rate of 15% [8]. Between April and November of 2020-2021, India exported dried flowers with a total value of 4.17 million US dollars [9].

Chrysanthemum (*Chrysanthemum morifolium* Ramat.) is a highly sought-after flower crop known for its ornamental value, and it is cultivated commercially in various countries. In India, it is typically grown outdoors in open fields, prized for its abundant loose flowers that come in a wide array of colours, shapes, and sizes. These flowers have a vase life of approximately 10 to 15 days, but their attractive appearance can be preserved for extended periods when stored in a dry state [10].The global trade market has a significant demand for dried chrysanthemum flowers, indicating their potential for economic growth. With this in mind, a study was conducted to standardize the embedded drying technology for chrysanthemum flowers (*Chrysanthemum morifolium* Ramat.), with the aim of encouraging entrepreneurship in floral crafts using dried chrysanthemum flowers.

2. Materials and methods:

The present investigation was carried out on “Studies on Effect of Different Substrates of Embedded Drying on Chrysanthemum (*Chrysanthemum morifolium* Ramat.)” during 2022-23 at Department of Horticulture, College of Agriculture, Lovely Professional University, Phagwara, Punjab. After being brought to the laboratory, chrysanthemum flowers were immediately embedded in various media (silica gel, borax, alum powder, river sand and saw dust). Flowers were placed in an upward position and dried at four different temperatures, namely 40^{o}C, 45^{o}C, 50^{o}C (in hot air oven) and room temperature (21^{o}C). A Factorial Completely Randomized Design was employed in conducting this experiment. The treatment combinations are T1- M1Te1 (Silica gel + Room temp.), T2- M1Te2 (Silica gel + 40^{o}C), T3-M1Te3 (Silica gel + 45^{o}C), T4- M1Te4 (Silica gel + 50^{o}C), T5-M2Te1 (Borax + Room temp.), T6-M2Te2 (Borax + 40^{o}C), T7-M2Te3 (Borax + 45^{o}C), T8-M2Te4 (Borax + 50^{o}C), T9-M3Te1 (Alum powder + Room temp.), T10-M3Te2 (Alum powder + 40^{o}C), T11-M3Te3 (Alum powder + 45^{o}C), T12-M3Te4 (Alum powder + 50^{o}C), T13-M4Te1 (River sand + Room temp.), T14-M4Te2 (River sand + 40^{o}C), T15-M4Te3 (River sand + 45^{o}C), T16-M4Te4 (River sand + 50^{o}C), T17-M5Te1 (Saw dust + Room temp.), T18-M5Te2 (Saw dust + 40^{o}C), T19-M5Te3 (Saw dust + 45^{o}C), T20-M5Te4 (Saw dust + 50^{o}C).

To conduct the experiment, borosilicate glass containers were chosen. A layer of desiccant, corresponding to the treatment, was poured into each container to a depth of approximately one inch. The flowers were then placed in an upright position on top of the desiccant. Care was taken to ensure that the shape of the flowers was not disturbed. The desiccant was gently poured over and around the flowers, filling the crevices between the petals to a height of 3-4cm. The containers were maintained at the specified temperatures in accordance with the treatment requirements. Throughout the experiment, utmost care was exercised to ensure the meticulous placement of the flowers into their designated desiccants within the containers, while avoiding any harm or injury to the delicate petals.Moreover, the entire flower was carefully covered with the desiccant to ensure that it was properly dried. After the dehydration process was completed for all twenty treatments, the containers were tilted to remove the desiccant that was poured over and around the flowers.The dried flowers were handled with care and manually removed from the trays. To clean the flowers, they were inverted, and the stems were tapped gently and slowly using fingers. After completing all the mentioned steps, the reduction in weight (fresh flower weight - dry flower weight), diameter reduction (fresh flower diameter - dry flower diameter), and perimeter reduction (fresh flower perimeter - dry flower perimeter) were measured and meticulously documented. In terms of appearance, the flowers were rated based on their colour and texture, using a scale of 1 to 5, where 1 represented "very poor," 2 represented "poor," 3 represented "good," 4 represented "very good," and 5 represented "excellent."

3. Result and discussion:

The present study conducted on the Effect of Different Substrates for Embedded Drying of Chrysanthemum (*Chrysanthemum morifolium* Ramat.) demonstrated the significant impact of various embedding materials on the parameters of dried flowers. The data presented in Tables 1 to 4 clearly indicate the notable influence of different dehydration treatments on the drying process of Chrysanthemum (*Chrysanthemum morifolium* Ramat.).Treatment 4, which involved using silica as the embedded medium at a temperature of 50°C, exhibited the highest reduction in flower weight, measuring 5.78 g. Statistically, this treatment showed superior performance in terms of weight reduction compared to all other treatments utilized in the experiment. Conversely, treatment 15, which utilized river sand as the embedded medium at a temperature of 45°C, demonstrated the lowest reduction in flower weight, recording a reduction of 1.97 g.

Table 1 Effect of different substrates of embedded drying on weight reduction (g) of flowers

Factors / Treatments	Room Temp. (21°C) (Te1)	40°C (Te2)	45°C (Te3)	50°C (Te4)	Mean
Silica gel (M1)	4.92	4.61	4.39	5.78	4.92
Borax (M2)	3.69	3.58	3.40	3.46	3.53
Alum powder (M3)	3.08	3.09	4.46	3.24	3.47
River sand (M4)	2.99	2.47	1.97	3.52	2.74
Saw dust (M5)	2.12	2.29	2.29	3.77	2.61
Mean	3.36	3.21	3.30	3.95	
Factors / Treatments			**C.D. at 5%**		
Media			0.056		
Temperature			0.074		

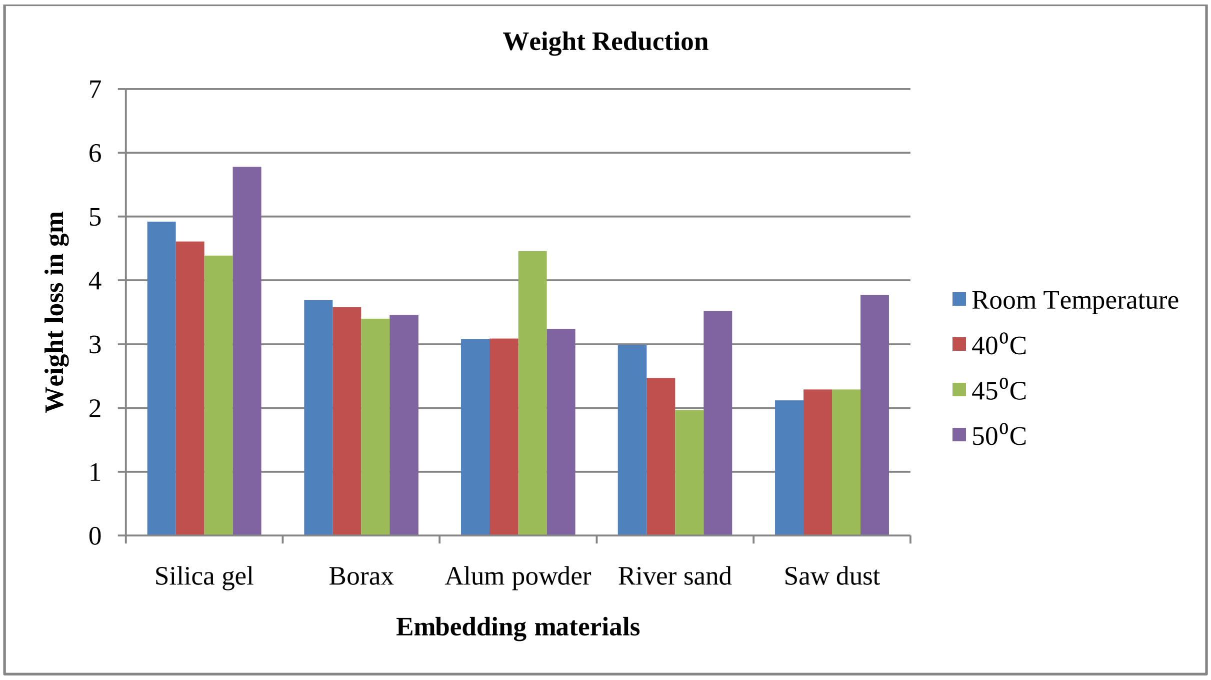

Figure 1. Effect of different substrates of embedded drying on weight reduction (g) of flowers

In terms of flower diameter reduction, treatment 19, which employed sawdust as the embedded medium at a temperature of 45°C, resulted in the maximum reduction of 1.60 cm. On the other hand, treatments 10 (using alum powder as the embedded medium at 40°C) and 13 (using river sand as the embedded medium at room temperature) displayed the minimum flower diameter reduction, measuring 0.81 cm and 0.87 cm, respectively

Table 2 Effect of different substrates of embedded drying on diameter reduction (cm) of flowers

Factors / Treatments	**Room Temp. (21°C) (Te1)**	**40°C (Te2)**	**45°C (Te3)**	**50°C (Te4)**	**Mean**
Silica gel (M1)	1.13	1.07	1.16	1.26	1.15
Borax (M2)	1.37	1.30	1.38	1.18	1.30
Alum powder (M3)	0.97	0.81	0.98	1.08	0.96
River sand (M4)	0.87	1.06	0.88	1.19	1.005
Saw dust (M5)	1.27	1.27	1.60	1.48	1.408
Mean	1.12	1.10	1.19	1.24	
Factors / Treatments			**C.D. at 5%**		
Media			0.019		
Temperature			0.017		

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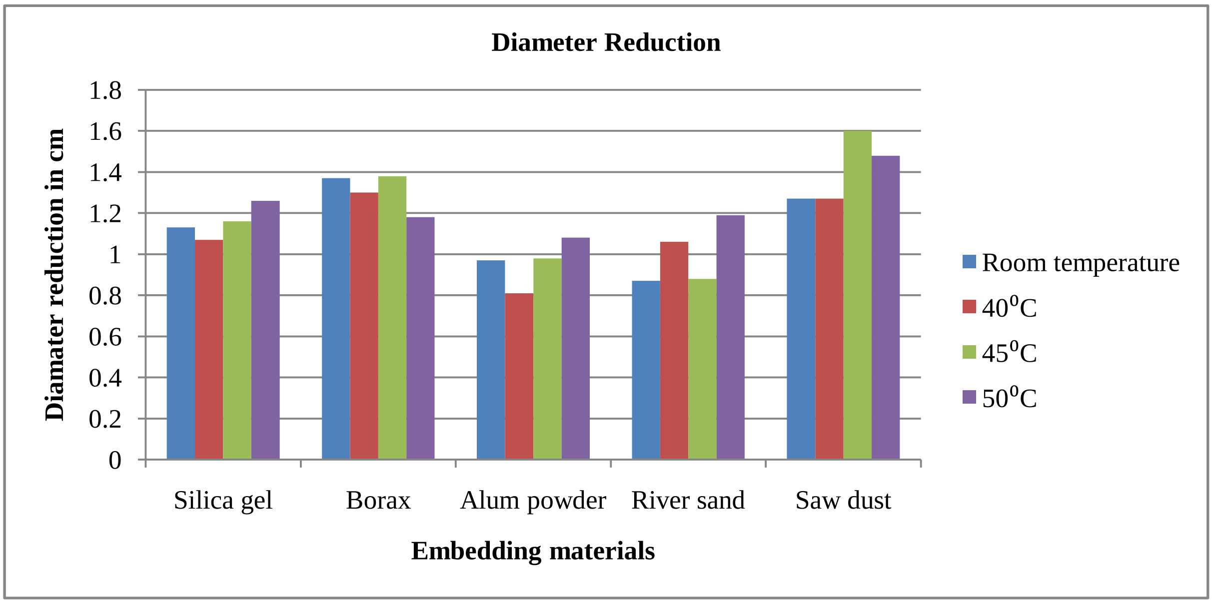

Figure 2. Effect of different substrates of embedded drying on diameter reduction (cm) of flowers

Regarding flower perimeter reduction, treatment 8, which incorporated borax as the embedded medium at a temperature of 50°C, exhibited the highest reduction of 2.78 cm. Conversely, treatments 10 (using alum powder as the embedded medium at 40°C) and 13 (using river sand as the embedded medium at room temperature) displayed the minimum flower perimeter reduction, measuring 1.67 cm.

Table 3 Effect of different substrates of embedded drying on perimeter reduction (cm) of flowers

Factors / Treatments	**Room Temp. (21^{o}C) (Te1)**	**40^{o}C (Te2)**	**45^{o}C (Te3)**	**50^{o}C (Te4)**	**Mean**
Silica gel (M1)	2.28	2.17	1.75	2.18	2.09
Borax (M2)	2.39	2.30	2.34	2.78	2.45
Alum powder (M3)	1.88	1.67	1.98	2.02	1.89
River sand (M4)	1.67	1.98	2.37	2.19	2.05
Saw dust (M5)	2.28	2.30	2.56	2.75	2.47
Mean	2.1	2.08	2.20	2.38	
Factors / Treatments			**C.D. at 5%**		
Media			0.024		
Temperature			0.022		

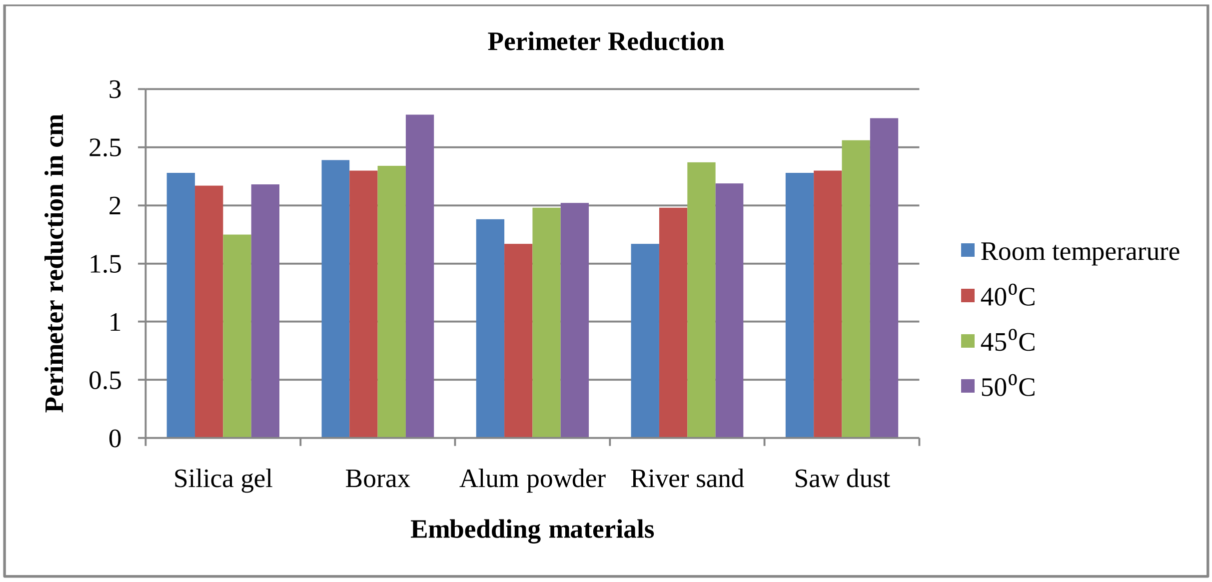

Figure 3. Effect of different substrates of embedded drying on perimeter reduction (cm) of flowers

Chrysanthemum flowers subjected to treatment 3, which involved using silica as the embedded medium at a temperature of 45°C, demonstrated excellent results in terms of appearance after the drying process. Borax, river sand, and sawdust as embedding media showed moderate to satisfactory outcomes in terms of the appearance of dried Chrysanthemum flowers. However, when alum powder was used as an embedding medium, the results were significantly poorer.

Table 4 Effect of different substrates of embedded drying on appearance of flowers (on the scale of 1 to 5)

Factors / Treatments	**Room Temp. (21°C) (Te1)**	**40°C (Te2)**	**45°C (Te3)**	**50°C (Te4)**	**Mean**
Silica gel (M1)	4.40	4.40	4.76	4.70	4.56
Borax (M2)	3.47	3.85	3.68	3.56	3.64
Alum powder (M3)	2.09	1.68	1.57	1.4	1.68
River sand (M4)	3.77	3.97	3.99	3.78	3.88
Saw dust (M5)	4.12	3.67	3.87	3.48	3.79
Mean	3.57	3.51	3.57	3.38	
Factors / Treatments			**C.D. at 5%**		
Media			0.057		
Temperature			0.051		

The use of silica gel as a dehydration agent at different temperatures produced better results compared to other drying materials for embedding. Chrysanthemum flower petals became papery after being treated with silica gel for 30-72 hours.The flowers retained their original colour and were conveniently manageable, maintaining a pleasing appearance and a smooth texture. Silica gel, known for its extensive network of interconnected microscopic pores, possesses the ability to attract and retain moisture [11]. This characteristic makes it a suitable desiccant choice for preserving the quality of fragile flowers. Previous studies have also found that silica gel is the most effective drying agent, due to its ability to penetrate the flowers' microspores and absorb moisture through capillary condensation and adsorption [12-14]. In this study, it was observed that embedding fresh flowers in river sand and sawdust resulted in the least weight reduction. This may be because these materials have larger particle sizes, which absorb less moisture. However, sand cannot retain moisture for long periods, and as a result, the flowers eventually reabsorb moisture [15].

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