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Morphological and Quality Parameters of Chrysanthemum Flowers as Influenced by Different Pre-drying Treatments and Drying Methods

Amita Gurjar[1], Nomita Laishram[1*], Arvinder Singh[1], R.K.Pandey[1], B.K. Sinha[2]

[1]Division of Floriculture & Landscaping, Sher-e-Kashmir University of Agricultural Science & Technology, Jammu, Chatha-180009 India.
[2]Division of Plant Physiology, Sher-e-Kashmir University of Agricultural Science and Technology, Jammu, Chatha-180009 India.

ABSTRACT

In the present study the flowers of chrysanthemum cv. Baggi were subjected to four different pre-drying treatments i.e. P_0 - Control (Soaking in Distilled water for 15 minutes); P_1 - Soaking in Citric acid (2%) for 15 minutes; P_2- Soaking in Magnesium Chloride (10 %) for 4 hours; P_3 - Soaking in Glycerol: water (1:3) for 24 hours and five drying techniques i.e. D_0 = Air drying at room temperature without embedding; D_1 = Embedded drying in Silica gel in a hot air oven at 50±5 °C; D_2 = Embedded drying in Silica gel in a microwave oven; D_3 = Embedded drying in Borax in hot air oven 50±5 °C and D_4 = Embedded drying in Borax in microwave oven in a factorial completely randomized design. Pre-drying treatment, Glycerol and Water in a 1:3 ratio proved best which resulted in a maximum dry flower weight of 0.83 grams, a minimal moisture loss of 67.45%, a maximum dry flower diameter of 4.24 centimeters, and a minimal reduction in diameter of 0.37 centimeters besides, a minimal drying time of 71.43 hours. In terms of quality parameters, the flowers treated with glycerol and water (1:3) had the highest scores for color (3.82), texture (2.76), shape (3.65), non-shattering of petals (3.87), and overall acceptability (3.64). Silica gel embedded flowers and drying them in a hot air oven resulted in a smaller reduction in diameter (0.20 centimeters) and achieved the highest scores for color (4.39), texture (4.18), shape (4.30), non-shattering of petals (4.20), and overall acceptability (4.54). The combination of the glycerol: water pre-treatment and the silica gel with a hot air oven drying method showed the least reduction in diameter (0.23 centimeters) and the highest scores for color (4.75), texture (4.60), shape (4.60), non-shattering of petals (4.55), and overall acceptability (4.75). Drying the flowers in a microwave oven with either desiccant resulted in the shortest drying time of 0.10 hours. On the other hand, air drying without embedding the flowers produced the lowest dry flower weight (0.46 grams), the highest percentage of moisture loss (82.44%), the smallest dry flower diameter (3.57 centimeters), and the largest reduction in diameter (1.00 centimeters). However, air drying took the longest time at 328.93 hours and resulted in dried flowers that were deemed unacceptable with minimal scores for color (2.70), texture (1.35), shape (1.95), and overall acceptability (2.35).

Keywords: *Desiccant, drying technique, chrysanthemum, pre-treatments, texture.*

Introduction

The longer life span and aesthetic appeal of the dehydrated flowers offer an advantage over the fresh flowers. The gaining popularity of dehydrated flowers as an alternative to fresh flowers for various decorative and commercial purposes is due to their eco-friendly nature and year-round usability, regardless of climate or season. Flowers and foliage can be dried through various techniques which primarily involve the reduction of moisture content of the plant tissue while preserving cell structure, pigment levels, and shape. Several methods are used for drying but air drying is the common method however it causes tissue shrinkage which is the only limitation, and that's why the "embedding approach" is often preferred [1]. Changes in petal color, such as browning or darkening are common due to heat-induced tissue damage during the drying processes. Pre-treatment using various chemicals like sodium bisulfate, magnesium chloride, and magnesium sulfate has shown significant effects on color and quality retention during the dehydration process of vegetables and flowers [19].

The availability of a wide range of vibrant colors in chrysanthemums including red, pink, orange, magenta, scarlet, and many more make it a highly significant flower crop worldwide [14]. With a vase life of only 10-15 days, chrysanthemums can also be preserved in dried form for an extended period. Dried chrysanthemum flowers are in high demand around the world [23]. Keeping the above factors in mind, the current research was carried out to standardize drying methods and various pre-treatments significantly impacting the final product's quality of dried chrysanthemum flowers.

Corresponding Author: **Nomita Laishram*
*Email Address: **nomitalaishram@gmail.com***

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Material and Methods

The research was carried out at the Division of Floriculture and Landscaping, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu & Kashmir from November 2021 to March 2022. The study aimed to evaluate the effects of different chemical pre-drying treatments and drying techniques on the flowers of the Chrysanthemum cultivar "Baggi". A total of 20 treatment combinations were tested in a factorial completely randomized design viz., four pre-drying treatments viz., P_0 - Control (Soaking in distilled water for 15 minutes); P_1 - Soaking in citric acid (2%) for 15 minutes; P_2- Soaking in Magnesium Chloride (10 %) for 4 hours; P_3- Soaking in glycerol: water (1:3) for 24 hours and five drying techniques i.e. D_0 = Air drying at room temperature without embedding; D_1 = Embedded drying in silica gel in a hot air oven at 50±5 °C; D_2 = Embedded drying in silica gel in a microwave oven; D_3 = Embedded drying in Borax in hot air oven 50±5 °C and D_4 = Embedded drying in Borax in a microwave oven. Each treatment was replicated three times. Healthy and uniform chrysanthemum flower stems were collected from the field during the morning hours at the full bloom stage. The stems were trimmed to a consistent length of 6 cm. The flowers were then immersed in the respective chemical solutions based on the assigned treatments. Afterward, the flowers were drained and allowed to evaporate the excess water on a cloth. Various drying techniques, as mentioned in the treatments, were employed to dry the pre-treated flowers. Air drying was performed by hanging the flowers upside down using a thread in a room with temperatures ranging from 15.6°C to 23.3°C. Inside the laboratory, the relative humidity (RH) ranged from 48.7% to 85.4%. Flowers treated with silica gel or borax were embedded in microwavable plastic containers and dried in either an electrically operated hot air oven or a microwave oven, depending on the treatment. After drying, the flowers were left at room temperature for approximately 3 hours for setting. The desiccants were removed by inverting the containers, and the dried flowers were hand-picked and cleaned. Any remaining desiccants were carefully removed using a fine brush. The moisture content of the petals was checked by pressing them with fingertips. If moisture was present, further drying was conducted to ensure complete moisture removal.

Several parameters were recorded, including flower fresh weight, dry weight, fresh flower diameter, dry flower diameter, reduction in diameter, percent moisture loss, and drying time. The quality parameters of the dried flowers, including color, shape, texture, overall acceptability, and non-shattering of petals, were evaluated by a panel of five judges using a five-point scale. The judges assigned scores based on the quality of the flowers, ranging from excellent to below average, with corresponding weights. The collected data was analyzed using a factorial Completely Randomized Design (CRD) methodology [13].

The amount of moisture lost as a result of drying was calculated using the formula below and expressed in percentage.

$$\text{Per cent moisture loss (\%)} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}} \times 100$$

Results and Discussion

Morphological parameters

No significant effects were observed in the fresh weight and diameter of flowers due to various treatments. The lack of variation in these parameters was due to the use of uniform flowers. When comparing different drying methods and pre-treatments (Table 1), it was found that flowers pre-treated with a glycerol and water (1:3) solution for 24 hours had the highest dry flower weight (0.91g) and the least amount of moisture loss (67.45%). In contrast, flowers pre-treated with 10% $MgCl_2$ had the lowest dry weight (0.56g) and the highest moisture loss (78.26%). This discrepancy can be attributed to the fact that glycerol, being a plasticizer, replaces the natural water content in plant material through osmosis. Such plasticizers are known to enhance the permeability of gases, liquids, and water vapor [2]. The results obtained are in agreement with previous work incarnation [15, 16], in gerbera [10], and on different types of ornamental foliage [9].

The highest dry flower weight (0.72g) was observed in flowers that were embedded in borax and dried in a hot air oven, and the lowest moisture loss (72.02%) was observed in the flowers that were embedded in borax and microwaved for 6 minutes. This outcome can be attributed to the fact that borax is less effective than silica gel in extracting moisture from the surrounding environment. Additionally, silica gel exhibits greater hygroscopic properties as an embedding medium compared to borax. Borax absorbs moisture at a slower rate and tends to solidify into lumps, which reduces the likelihood of moisture evaporation from the flowers [4]. Similar findings have been reported in previous studies conducted on carnation [12] and on yellow button chrysanthemums [11]. When the flowers were air-dried without embedding, the lowest dry weight (0.46g) and the highest moisture loss (82.44%) were observed. This can be attributed to the fact that the flowers were directly exposed to the microclimate for an extended period, leading to greater moisture evaporation [20]. The findings of this study align with previous research conducted on rose buds [6]. However, in contrast to our study, Wilson et al. [23] found that embedded drying led to the highest moisture loss compared to air drying when working with chrysanthemums. These variations in results could be attributed to differences in the specific flower species, experimental conditions, and methodology used in each study. The interactive effect of pre-drying treatments and drying methods on dry weight and moisture loss was found to be significant. The highest dry flower weight (0.91g) and least moisture loss (64.04%) were observed in flowers that underwent a pre-treatment of glycerol and water (1:3) for 24 hours and were dried by embedding in borax and using a hot air oven. Similarly, flowers that were pre-treated with glycerol and water (1:3) for 24 hours and dried by embedding in silica gel using a microwave oven also had a dry weight of 0.91g. On the other hand, the lowest dry flower weight (0.38g) and highest moisture loss (85.32%) were observed in flowers that were pre-treated with 10% $MgCl_2$ and air dried at room temperature in shade without embedding (Table 1).

The pre-drying treatments had a significant impact on both dry flower diameter and relative shrinkage. Flowers that underwent pre-treatment with glycerol and water (1:3) for 24 hours had the largest dry flower diameter (4.24cm) with the least amount of shrinkage (0.37cm). Conversely, flowers pre-treated with water (control) recorded the smallest diameter (4.13cm) which was similar to 10% $MgCl_2$ pre-treated flowers (4.13cm). The highest amount of shrinkage (0.48 cm) was seen in flowers that had been pre-treated with distilled water. The choice of drying technique also affected the dry flower diameter and relative shrinkage. By drying flowers in a microwave oven while embedded in silica gel, the largest dry flower diameter (4.37cm) was obtained and the least amount of shrinkage (0.23cm) was observed when flowers were dried in a hot air oven and embedded in silica gel. In contrast, the smallest dry flower diameter (3.57cm) and the highest amount of shrinkage (1.00cm) were recorded when flowers were dried at room temperature in the shade without being embedded. These conclusions concur with those made by Dhatt et al. [5], Wilson et al. [23] regarding the chrysanthemum, Verma et al. [22], and Akram et al. [3] about the Cleretum bellidiforme and Calendula officinalis. However, another study shows that microwave-dried rose buds tend to shrink less than those that are dried in a room or a hot air oven [1]. The flower diameter decreased substantially with the combination of pre-treatments and drying methods. Flowers pre-treated with glycerol: water (1:3) for 24 hours, dried in a microwave oven, and embedded in silica gel showed the greatest dry flower diameter (4.46cm). The least diameter reduction (0.20 cm) was seen in flowers that had been pre-treated with 1:3 glycerol: water and dried in a hot air oven while being embedded in silica gel. The smallest dry flower diameter (3.48cm) and the highest shrinkage (1.09 cm) were air-dried at room temperature without embedding and pre-treated with distilled water (Table 1).

Among all the pre-drying procedures, 10% $MgCl_2$ pre-treatment required the longest length of time (77.16h) to dry the flowers, on the other hand following a 24-hour pre-treatment with glycerol and water (1:3), the least drying time for flowers (71.43 h) was noted. The likely perpetrator may be the drying property of glycerol, which replaces the native water molecules in flowers through osmosis and causes the bloom to dry earlier than anticipated [10]. The outcomes concur with those reported by Adiga et al. [2] for gerbera and Ravichandra and Pedapathi [16] for carnation. Different drying techniques had a significant impact on the drying time of flowers. The quickest drying time for flowers was achieved in the microwave oven (0.10h), while the longest drying time was achieved when air drying flowers in the shade at room temperature (328.93 hours). This could be a result of the water molecules being agitated by electronically generated microwaves, which release the most moisture quickly. Additionally, the powerful hygroscopic qualities of borax and silica gel also contribute to the results indicated above [20]. The results concur with Singh et al. [21] findings on zinnia flowers and Safeena et al. [18] findings on roses. It was discovered that the interaction effects of pre-treatments and drying techniques on drying time were significant. Flowers were pre-treated with any of the chemicals, embedded in silica gel or borax, and microwaved and dried more quickly (0.10h). The longest drying time (336.00 hours) was required for air-dried flowers without embedding that had been pre-treated with water and 10% $MgCl_2$ (363.20 hrs.) (Table 1).

Flower quality parameters

The highest ratings for color (3.82), texture (2.76), shape retention (3.65), non-shattering of petals (3.87), and overall acceptability (3.64) were given to flowers pre-treated with a 1:3 glycerol: water solution for 24 hours. In contrast, the lowest ratings were given to flowers pre-treated with water (control), which received ratings for color (3.00), texture (2.14), non-shattering of petals (3.21), and overall acceptability (3.13). The flowers that had been pre-treated with 10% magnesium chloride for five hours had the lowest form retention score (3.16). Hygroscopic substances called humectants, like glycerol, pull water vapor from the air to keep plant material flexible, making preserved plant material less brittle and more lifelike [2]. The results are in line with those of Patil et al. [15] for gerbera, Mathapati et al. [10] for gerbera, and Ravichandra and Pedapathi [16] for carnations. The lowest ratings for color (2.70), texture (1.35), shape retention (1.95), and overall acceptability (2.35) were given to air-dried flowers without embedding. Flowers that were dried in a microwave oven while being embedded in borax also obtained a minimum grade of (1.35) for texture and (2.38) for petals that did not shatter. This might be caused by changes in the microclimate's relative humidity, which would lead to uneven drying and cracking and have an impact on the shape, color, and other characteristics of the quality of the flower [20]. Flowers dried in a hot air oven with silica gel embedded produced more acceptable flowers in terms of color (4.39), texture (4.18), shape (4.30), non-shattering of petals (4.20), and overall acceptability (4.54). When dried in a hot air oven, flowers embedded in silica gel received the highest scores for better appearance as reported by Nair et al. [11]. These findings are consistent with those of Sindhuja *et al*. [20] for carnations, Nair et al. [11] for chrysanthemums, Safeena and Patil [17] for roses, Akram et al. [3] who confirmed that Cleretum bellidiforme and Calendula officinalis silica gel embedded flowers were the best in terms of texture and appearance. According to Lalhruaitluangi [8], rose flowers dried in hot air ovens and embedded in silica gel obtained the top ratings from tasters for flower color, flower form, flower texture, and overall acceptance. In a different experiment, Acharyya et al. [1] found that silica gel worked best as an embedding medium for preserving the color, texture, and shape of dried rose buds in a microwave. The interaction of pre-drying treatments and drying techniques significantly influenced the dry flower quality parameters. Maximum scores for color (4.75), texture (4.6), shape (4.6), non-shattering of petals (4.55), and overall acceptability (4.75) were obtained with flower pre-treatment in glycerol: water (1:3) and drying in hot air oven embedded in silica gel. The lowest color (2.20), texture (1.10), shape retention (1.4), and overall acceptability (2.1) non-petal shattering scores (2.0) were obtained when flowers were pre-treated with water and dried in air (shade) without embedding. The lowest texture ratings (1.10) were likewise seen in flowers that had been pre-treated with 10% magnesium chloride and dried in a hot air oven with borax. The lowest non-shattering of petals ratings (1.9) were observed when flowers were pre-treated with water and dried in a microwave oven with borax (Table 2).

Conclusion

From the above studies, it can be concluded that soaking of chrysanthemum flowers in glycerol: water (1:3) ratio for 24 hours before dehydration treatment resulted in the best quality dried flowers and hot air oven drying at $55\pm1^{\circ}C$, embedding in silica gel generated the best-dried chrysanthemum flowers when compared to other drying methods.

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Conflict of interest: Conflicts of interest are disclosed by the authors.

TABLE 1: Effect of Pre-drying preservation treatments and the ideal drying technique on fresh weight, dry weight, moisture loss, fresh flower diameter, dry flower diameter, reduction in diameter, and time taken to dry Chrysanthemum (Chrysanthemum morifolium Ramat.)

Pretreatments	Parameters						
	Fresh weight (g)	**Dry weight (g)**	**Moisture loss (%)**	**Fresh flower diameter (cm)**	**Dry flower diameter (cm)**	**Reduction in diameter (cm)**	**Time taken to dry (hours)**
P_0 - Control (Soaking in distilled water for 15 min)	2.57	0.58	77.44	4.60	4.13	0.48	77.05
P_1 - Soaking in citric acid (2%) for 15 min	2.59	0.58	77.60	4.60	4.20	0.40	76.13
P_2 - Soaking in Magnesium Chloride (10 %) for 4 hours	2.57	0.56	78.26	4.57	4.13	0.44	77.16
P_3 - Soaking in glycerol: water (1:3) for 24 h	2.56	0.83	67.45	4.61	4.24	0.37	71.43
$CD_{0.1}$	NS	0.01	0.47	NS	0.02	0.025	1.54
SEM±	0.01	0.01	0.16	0.03	0.01	0.009	0.54
Drying methods	**Fresh weight (g)**	**Dry weight (g)**	**Moisture loss (%)**	**Fresh flower diameter (cm)**	**Dry flower diameter (cm)**	**Reduction in diameter (cm)**	**Time taken to dry (hours)**
D_0 = Air drying at room temperature without embedding	2.61	0.46	82.44	4.57	3.57	1.00	328.93
D_1 = Embedded drying in silica gel in a hot air oven at 50±5 °C	2.58	0.66	74.55	4.58	4.35	0.23	23.92
D_2 = Embedded drying in silica gel in a microwave oven	2.56	0.64	74.79	4.61	4.37	0.25	0.10
D_3 = Embedded drying in Borax in a hot air oven 50±5 °C	2.57	0.72	72.15	4.61	4.30	0.31	24.17
D_4 = Embedded drying in Borax in a microwave oven	2.55	0.71	72.02	4.62	4.29	0.32	0.10
$CD_{0.1}$	NS	0.02	0.52	NS	0.02	0.028	1.72
SEM±	0.02	0.01	0.18	0.04	0.01	0.010	0.60

TABLE 2: Effect of Pre-drying preservation treatments and the ideal drying technique on color, texture, shape, non-shattering of petals, and overall acceptability scores of Chrysanthemum (Chrysanthemum morifolium Ramat.)

Pretreatments	Parameters				
	Color	**Texture**	**Shape**	**Nonshattering of petals**	**Overall acceptability**
P_0 - Control (Soaking in distilled water for 15 min)	3.00	2.14	3.18	3.21	3.13
P_1 - Soaking in citric acid (2%) for 15 min	3.46	2.50	3.37	3.35	3.38
P_2 - Soaking in Magnesium Chloride (10 %) for 4 hours	3.46	2.36	3.16	3.41	3.41
P_3 - Soaking in glycerol: water (1:3) for 24 h	3.82	2.76	3.65	3.87	3.64
Drying methods	**Color**	**Texture**	**Shape**	**Non-shattering of petals**	**Overall acceptability**
D_0 = Air drying at room temperature without embedding	2.70	1.35	1.95	3.88	2.35
D_1 = Embedded drying in silica gel in a hot air oven at 50±5 °C	4.39	4.18	4.30	4.20	4.54

D_2 = Embedded drying in silica gel in a microwave oven	4.26	3.98	4.03	4.16	4.45
D_3 = Embedded drying in Borax in a hot air oven 50±5 °C	2.93	1.35	3.29	2.69	2.98
D_4 = Embedded drying in Borax in a microwave oven	2.90	1.38	3.14	2.38	2.64
Interaction P X D	**Color**	**Texture**	**Shape**	**Non-shattering of petals**	**Overall acceptability**
P_0D_0	2.20	1.10	1.70	3.60	2.10
P_0D_1	4.00	3.90	4.00	3.95	4.20
P_0D_2	3.90	3.40	3.90	4.00	4.25
P_0D_3	2.40	1.20	3.30	2.60	2.60
P_0D_4	2.50	1.20	3.00	1.90	2.50
P_1D_0	2.60	1.40	2.00	3.80	2.30
P_1D_1	4.30	4.20	4.20	4.20	4.55
P_1D_2	4.20	4.00	4.10	4.10	4.40
P_1D_3	3.00	1.50	3.35	2.45	3.10
P_1D_4	3.20	1.40	3.20	2.20	2.55
P_2D_0	2.70	1.20	1.40	3.90	2.40
P_2D_1	4.50	4.00	4.40	4.10	4.65
P_2D_2	4.40	4.10	3.90	4.15	4.50
P_2D_3	2.80	1.10	3.00	2.50	3.00
P_2D_4	2.90	1.40	3.10	2.40	2.50
P_3D_0	3.30	1.70	2.70	4.20	2.60
P_3D_1	4.75	4.60	4.60	4.55	4.75
P_3D_2	4.55	4.40	4.20	4.40	4.65
P_3D_3	3.50	1.60	3.50	3.20	3.20
P_3D_4	3.00	1.50	3.25	3.00	3.00

NOTE: The scores were given on a scale of 1-5 (0-1: below average, 1.1-2: bad, 2.1-3: good, 3.1-4: very good, 4.1-5: excellent)

Fig 1: Interaction effect of Pretreatments X Drying method on Fresh weight (g)

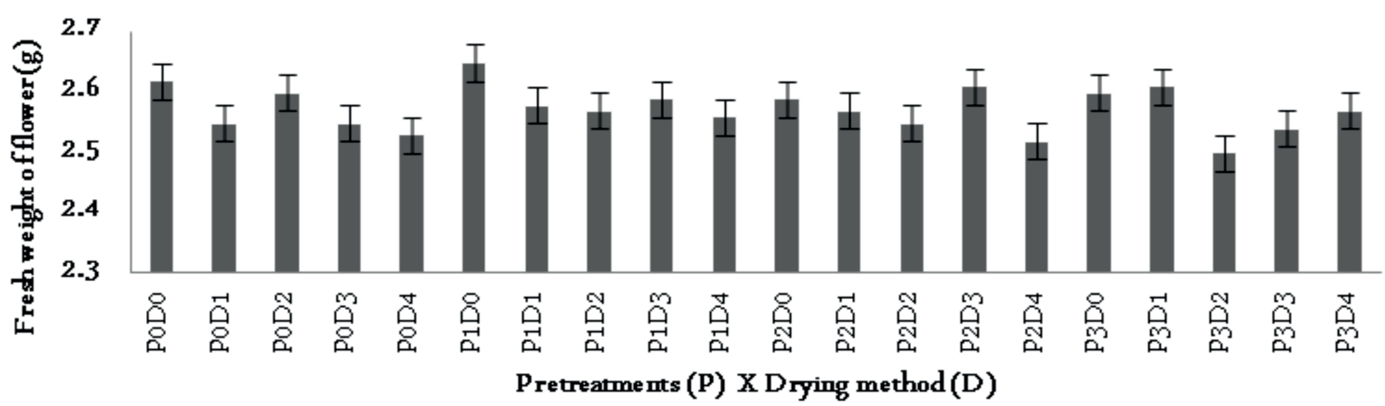
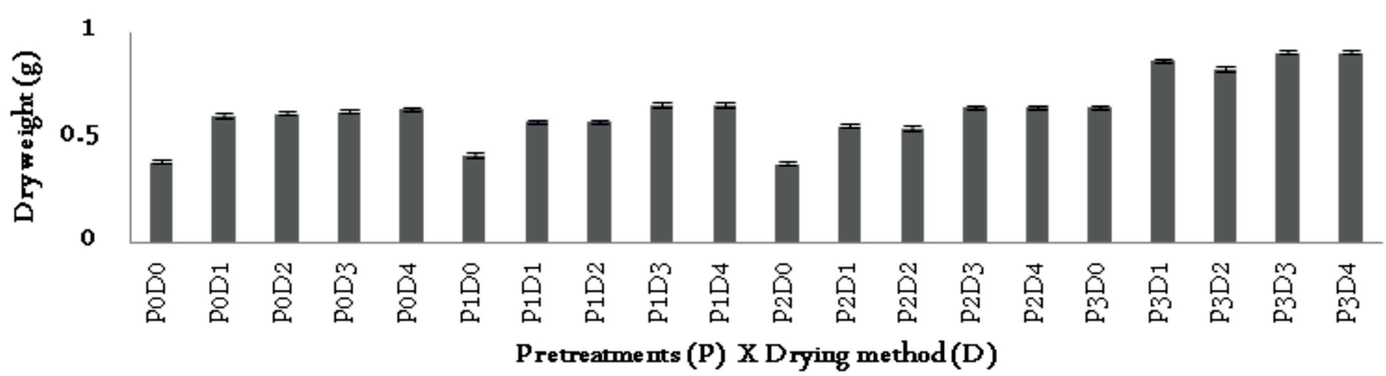


Fig 2: Interaction effect of Pretreatments X Drying method on Dry weight (g)



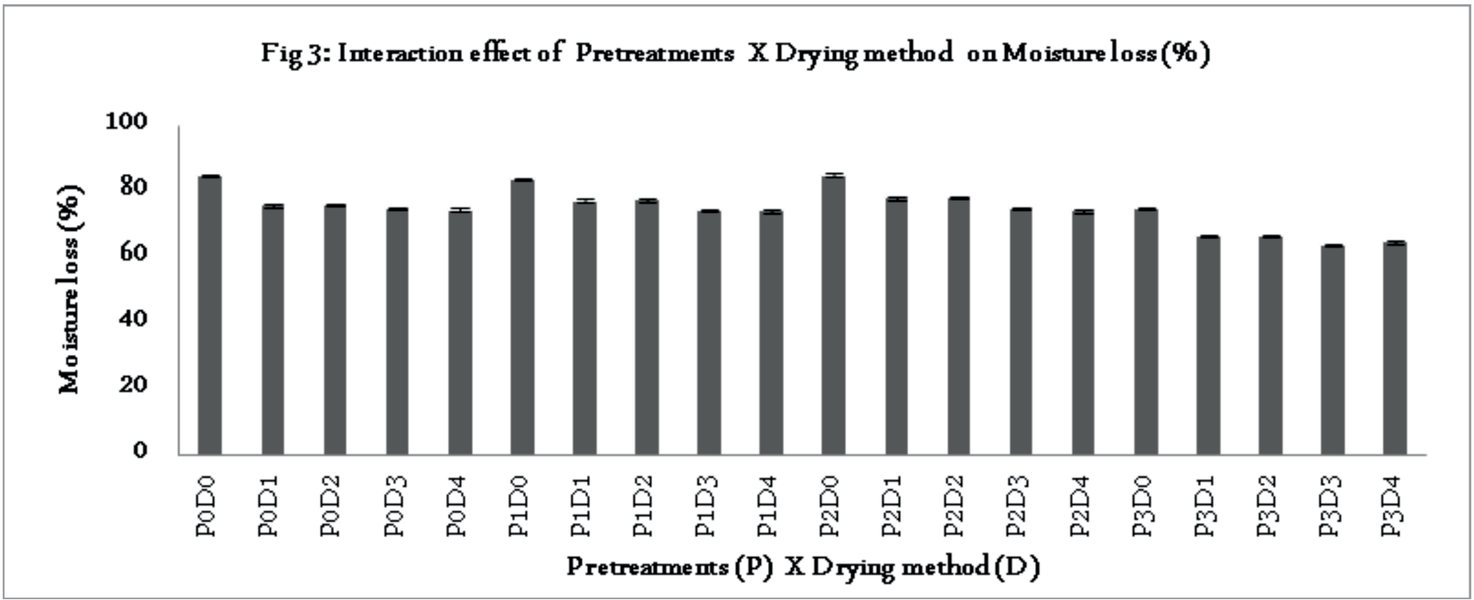


Fig 3: Interaction effect of Pretreatments X Drying method on Moisture loss (%)
Moisture loss (%)
100
80
60
40
20
0
P0D0
P0D1
P0D2
P0D3
P0D4
P1D0
P1D1
P1D2
P1D3
P1D4
P2D0
P2D1
P2D2
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P3D4
Pretreatments (P) X Drying method (D)

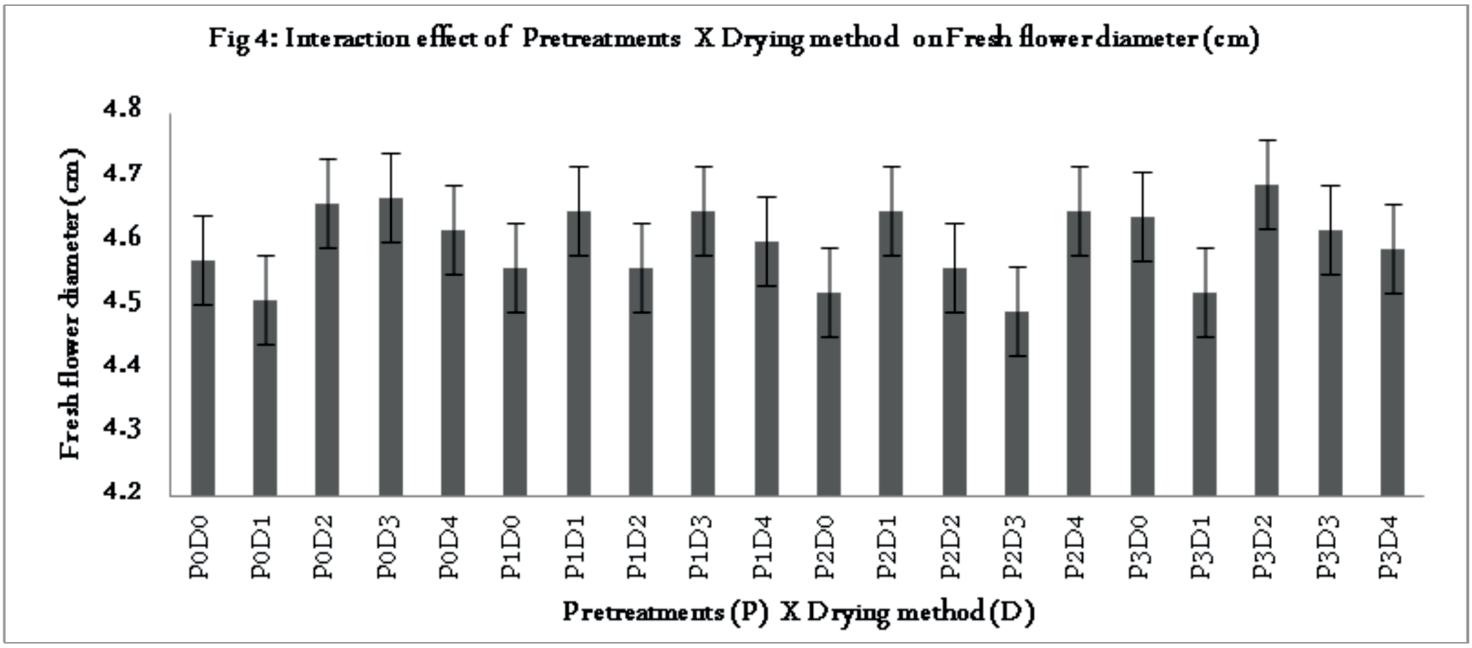


Fig 4: Interaction effect of Pretreatments X Drying method on Fresh flower diameter (cm)
Fresh flower diameter (cm)
4.8
4.7
4.6
4.5
4.4
4.3
4.2
P0D0
P0D1
P0D2
P0D3
P0D4
P1D0
P1D1
P1D2
P1D3
P1D4
P2D0
P2D1
P2D2
P2D3
P2D4
P3D0
P3D1
P3D2
P3D3
P3D4
Pretreatments (P) X Drying method (D)

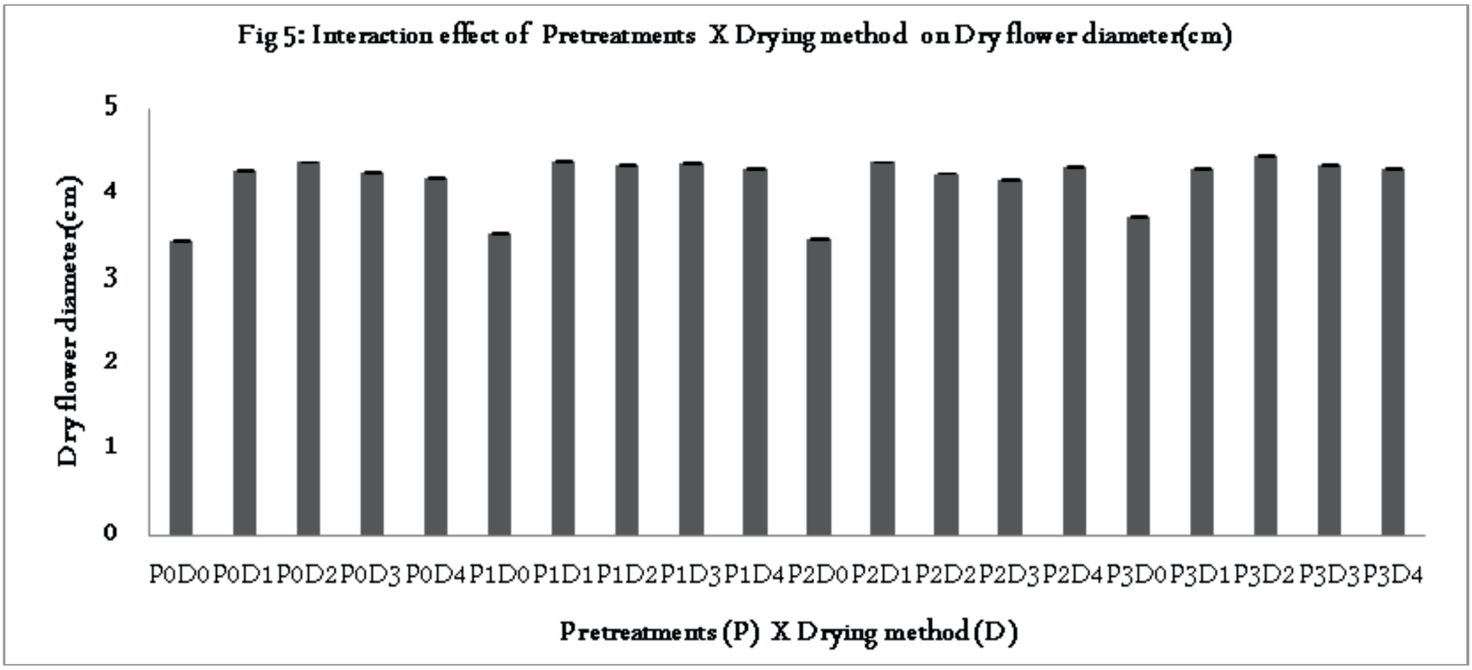
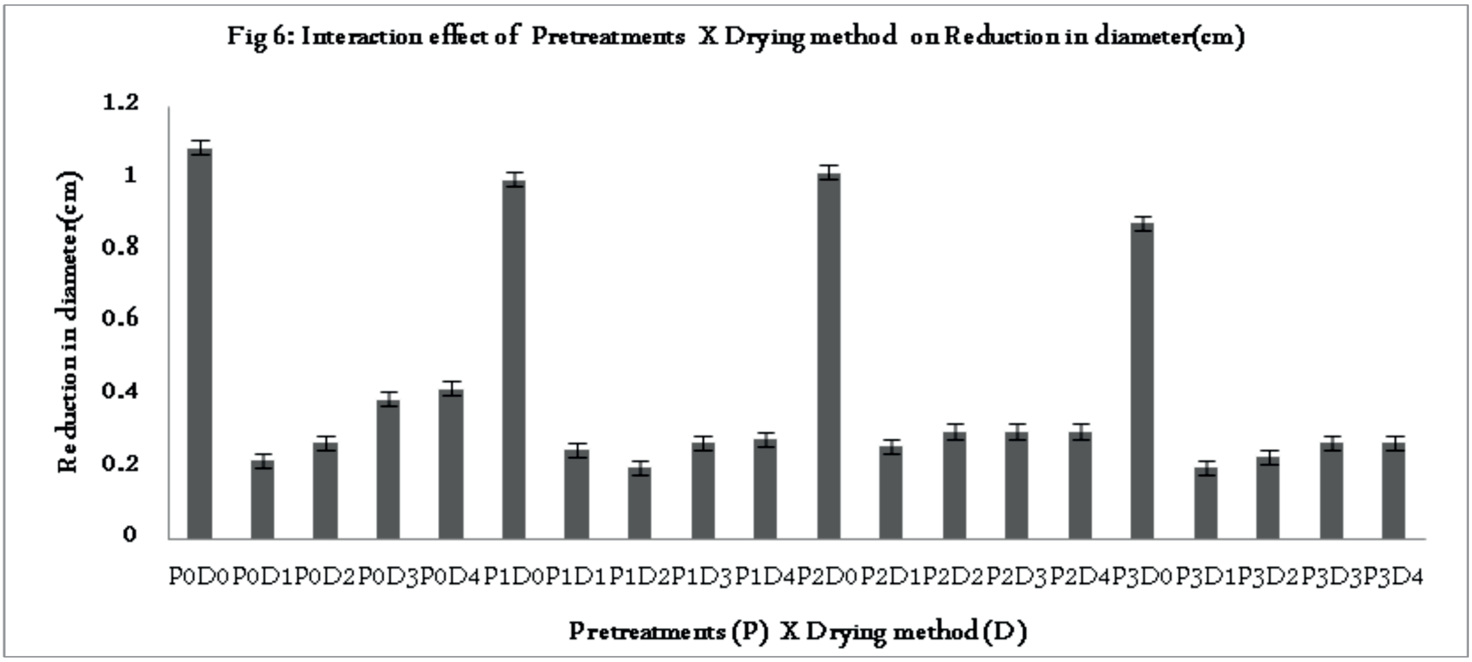


Fig 5: Interaction effect of Pretreatments X Drying method on Dry flower diameter(cm)
Dry flower diameter(cm)
5
4
3
2
1
0
P0D0
P0D1
P0D2
P0D3
P0D4
P1D0
P1D1
P1D2
P1D3
P1D4
P2D0
P2D1
P2D2
P2D3
P2D4
P3D0
P3D1
P3D2
P3D3
P3D4
Pretreatments (P) X Drying method (D)



References

1. Acharyya P, Biswas S, Saha S, Chakraborty L (2013) Studies on methods of dehydration of rose buds 'Gold Medal' and 'Minu Parle'. International Conference on Quality Management in Supply Chains of Ornamentals QMSCO2012 970 pp. 293-298.
2. Adiga JD, Patil MS, Kulkarni BS (2014) Standardization of glycerol pre-treatment for drying of gerbera flowers. Journal of Ornamental Horticulture 17(1&2): 18-22.
3. Akram, Thaneshwari, Sharma P (2021) Standardizing dehydration technique for Cleretum bellidiforme and Calendula officinalis. The Pharma Innovation Journal 10(6): 458- 461.
4. Chandana S, Malam VR, Jain SNR (2021) Evaluation of different drying methods and desiccants on physical parameters of annual chrysanthemum and gerbera. The Pharma Journal 10(12): 938-945.
5. Dhatt KK, Singh K, Kumar R (2007) Studies on methods of dehydration of rose buds. Journal of Ornamental Horticulture 10(4): 264-267.
6. Dilta BS, Sharma BP, Baweja HS, Kashyap B (2011) Flower drying techniques-A review. International Journal of Farm Sciences 1(2): 1-16.
7. Jawaharlal M, Visalakshi M, Cintu S, Ganga M (2013) Standardization for drying, bleaching and dyeing processes in dried flowers. Journal of Horticultural Sciences 8(1): 65-69.
8. Lalhruaitluangi CK (2017) Standardization of drying techniques for hybrid tea rose variety, Valencia. Science Vision 17(4): 217-221.
9. Malakar M, Acharyya P, Biswas S (2016) Standardization of dehydration techniques of some ornamental foliages. International Journal of Agriculture, Environment and Biotechnology 9(4): 555-562.
10. Mathapati S, Naik BH, Anand N, Suresh C (2016) Standardization of pre-treatment of glycerol for drying of gerbera var. Imperial under laboratory condition. Environment and Ecology 34(1A): 221-224.
11. Nair B, Singh KP, Vidhya Sankar M (2011) Effect of different temperatures and desiccants on quality of yellow button type chrysanthemum flowers. JNKVV Res. Journal. 45(2): 172-174.
12. Nirmala A, Chandrasekhar R, Padma M, Sankar AS (2008) Effect of different media and cabinet hot air oven drying on production of quality dry flowers in carnation. Journal of Ornamental Horticulture 11(4): 260-264.
13. Panse VG and Sukhatme PV.1985. Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi.
14. Panwar S, Kundu A (2018) Influence of drying techniques on retention of anthocyanin and their antioxidant activities in chrysanthemum (Chrysanthemum × morifolium) flowers. Indian Journal of Agricultural Sciences 88(2): 228-33.
15. Patil KV, Gangadharappa PM, Karadiguddi MB, Patil RT (2011) Standardization of pre-treatment of glycerol for drying of carnation (Dianthus caryophyllus) flowers. Journal of Ecobiology 29(4): 267.
16. Ravichandra S, Pedapati A (2014) Effect of pre-drying treatment on carnation dried flower quality. Journal of Agri. Search 1(1): 35-39

17. Safeena SA, Patil VS (2013) Effect of hot air oven and microwave oven drying on production of quality dry flowers of Dutch roses. Journal of Agricultural Science 5(4): 179-189.

18. Safeena SA, Patil VS, Naik BH (2006) Response of drying in hot air oven on quality of rose flowers. Journal of Ornamental Horticulture 9(2): 114-117.

19. Shailza SJ, Grewal HS (2018) Emerging prospective of floriculture industry: Drying of ornamental plants and their parts. International Journal of Current Microbiology and Applied Sciences 7(7): 1619-1633.

20. Sindhuja S, Padmalatha T, Padmavathamma AS (2015) Effect of embedding media on production of quality dry flowers in carnation. Plant Archives 15(1): 27-33.

21. Singh A, Dhaduk BK, Shah RR (2004) Effect of different temperatures and embedding media on flower dehydration of zinnia (Zinnia linearis Benth.). Indian Journal of Horticulture 61(3): 249-252.

22. Verma AK, Dhiman MR, Kumar D, Gupta A (2012) Preserving flowers and plant parts, In: Post harvest technology for commercial floriculture. New India Publishing Agency New Delhi, India. pp. 143- 171.

23. Wilson D, Attri BL, Sharma SK (2015) Evaluation of different methods for drying of chrysanthemum flowers. Progressive Horticulture 47(1): 167-169.