International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; 9(8): 194-201
www.biochemjournal.com
Received: 24-05-2025
Accepted: 27-06-2025

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Effect of dehydration techniques on aesthetic and phytochemical parameters of chrysanthemum flower varieties

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DOI: https://www.doi.org/10.33545/26174693.2025.v9.i8c.5129

Abstract
The floriculture industry holds significant economic importance in India with increasing demand for dry flowers. Study aimed to evaluate four dehydration techniques (sun, shade, vacuum and silica gel embedded drying) on the aesthetic and phytochemical properties of six chrysanthemum varieties (Dolly White, Pacho, Agina Purple, Ratlam Selection, Sunil and Flirt) to identify optimal preservation methods. Study was conducted at Anand Agricultural University from December 2023 to June 2024, the research applied dehydration techniques to harvested flowers targeting 15% moisture content, aesthetic parameters and key phytochemicals were then subsequently analyzed. Results showed that embedded drying with silica gel generally showed higher results for preserving aesthetic and most of the phytochemical parameters including texture, phenols, flavonoids and carotenoids especially in 'Flirt' and 'Agina Purple'. Shade drying excelled in retaining ascorbic acid and antioxidant activity particularly in 'Agina Purple'. Sun drying maximized total soluble sugars in 'Pacho' but led to significant losses in ascorbic acid and flavonoids. Vacuum drying resulted in the lowest retention of anthocyanin and antioxidant activity. Varietal performance also varied with 'Dolly White' showing best aesthetic preservation, 'Flirt' showing highest results in phenols and flavonoids and 'Agina Purple' showing highest results in anthocyanin, ascorbic acid and antioxidant activity. In conclusion, embedded drying was found to be effective for overall preservation while shade drying was optimal for ascorbic acid and antioxidant activity. Specific variety-dehydration technique combinations are crucial for targeted quality retention offering valuable insights for value addition in dried chrysanthemum products.

Keywords: Chrysanthemum, dehydration techniques, floriculture, value-addition

Introduction
Floriculture, the cultivation and management of flowers and ornamental plants has emerged as a significant sector in India's horticulture industry recognized as a "sunrise industry" due to its robust export potential and profitability. The industry's growth is propelled by increasing domestic and international demand for flowers in various ceremonies and events as well as their applications in perfumes, medicines and decorative purposes. As per a report from the Department of Agriculture & Farmers Welfare, India had approximately 285 thousand hectares under flower crops, yielding around 2.284 million tonnes of loose flowers and 947 thousand tonnes of cut flowers in 2023-2024.

Chrysanthemum a popular flower of the Composite (Asteraceae) family holds significant economic and cultural importance worldwide. It is one of the most widely grown ornamental crops globally and ranks among the top ten cut flowers. Chrysanthemums are native to East Asia where they have been cultivated for over 2,500 years. Their popularity stems from their diverse flower forms, colours and long vase life making them ideal for cut flowers, potted plants and landscape ornamentation. Additionally, they are used in traditional medicine and as a source of natural insecticides.

The rising global interest in sustainable and eco-friendly products has further boosted the demand for dry flowers which offer a unique appeal due to their extended shelf life, versatility in arrangements and reduced environmental impact compared to fresh flowers. They are used in various applications including home décor, potpourri, crafts and floral art. The process of drying flowers involves removing moisture while preserving their aesthetic qualities such as colour, shape, and texture. Effective dehydration techniques are crucial to ensure that the dried flowers retain their natural beauty and can be used for various value-added products. Proper drying not only preserves the aesthetic appeal but also helps in retaining the phytochemical components which contribute to the medicinal and aromatic properties of the flowers. This study focuses on optimizing these dehydration techniques for Chrysanthemum varieties aiming to enhance their value and extend their usability.

Material and Methods

This investigation was conducted from December 2023 to June 2024 at Anand Agricultural University, Anand, Gujarat. Six chrysanthemum varieties (Dolly White, Pacho, Agina Purple, Ratlam Selection, Sunil and Flirt) were propagated from cuttings in July 2023 and transplanted in August 2023 at a spacing of 45 x 45 cm. Standard cultural practices including fertilization, irrigation, pest and disease management were followed. Fully opened, pest and disease-free flowers were harvested in January 2024 and subjected to four dehydration techniques:

- **Sun Drying:** Flowers were exposed to direct sunlight (9:00 a.m. to 5:00 p.m.) until moisture content reached 15% with durations varying by variety (10-22 days).
- **Shade Drying:** Flowers were dried in a well-ventilated room away from direct sunlight following similar moisture content goals (12-25 days).
- **Vacuum Drying:** Flowers were dried in a vacuum oven at 65°C and 100 mmHg pressure to achieve 15% moisture.
- **Embedded Drying with Silica Gel:** Flowers were fully embedded in silica gel within airtight containers and kept in a dark and dry room.

Aesthetic parameters (flower colour, shape, brittleness, intactness, texture and overall appearance) were evaluated using ad-hoc scales (Stone *et al.*, 2020) [20]. Phytochemical analyses included total phenols (Bray and Thorpe, 1954) [20], total flavonoids (Zhishen *et al.*, 1999) [21], total anthocyanin (Fuleki and Francis, 1968) [23], total carotenoids (Sadasivam, 1996) [23], ascorbic acid (Loeffler and Ponting, 1942) [24], total antioxidant activity (Modified from Benzie and Strain (1996) [25], total soluble sugars (Dubois *et al.*, 1956) [26] and Chromatographic pigment profile analyses (Singh and Gupta, 2014) [27] and after that statistical analysis was performed for all parameters using Completely Randomized Design-Factorial (Panse and Sukhatme, 1967) [28].

Result

The effect of different dehydration techniques and varieties with their interaction effect on aesthetic and phytochemical parameters are depicted in Tables 1, 2 and 3.

5.1 Effect of drying techniques on aesthetic parameters and phytochemical parameters of chrysanthemum flowers

- Embedded drying with silica gel (D_4) resulted in significantly best flower colour retention (7.11) followed by shade drying (D_2) with a mean score of 6.62 and vacuum drying (D_3) showed significantly lowest score 5.16.
- Significantly highest score 7.06 for flower shape was recorded in embedded drying with silica gel (D_4) followed by shade drying (D_2) scoring 6.58 and vacuum drying (D_3) scored significantly lowest at 5.10.
- Vacuum drying (D_3) was observed to have significantly poorest score for flower brittleness (5.53) while embedded drying with silica gel (D_4) maintained significantly highest score for flower brittleness (6.93) followed by shade drying (D_2) at 6.62.
- Embedded drying with silica gel (D_4) was most effective in preserving flower intactness with significantly highest mean score 6.80. Shade drying (D_2) followed with the mean score 6.54 and vacuum drying (D_3) was found significantly lowest with mean score 5.60.
- In terms of flower texture embedded drying with silica gel (D_4) resulted in the significantly best texture preservation with mean score 7.05 with shade drying (D_2) scoring 6.63 followed while vacuum drying (D_3) resulted in significantly poorest texture preservation with mean score 5.24.
- Overall appearance was found significantly highest in embedded drying with silica gel (D_4) having mean score 7.26 followed by shade drying (D_2) at 6.72. Vacuum drying (D_3) scored significantly lowest with mean score 5.52.
- Total phenols was preserved best in embedded drying with silica gel (D_4) showing significantly highest amount 2256 mg/100g dry weight followed by shade drying (D_2) having 1961 mg/100g dry weight and vacuum drying (D3) retained significantly least amount of total phenols (1460 mg/100g dry weight).
- Embedded drying with silica gel (D_4) preserved significantly highest amount of total flavonoids (1439 mg/100g dry weight) followed by shade drying (D_2) with total flavonoid content of 1073 mg/100g dry weight whereas, vacuum drying (D_3) retained significantly lowest total flavonoids (768 mg/100g dry weight).
- Highest total anthocyanin retention of 133.60 mg/100g dry weight was found in embedded drying with silica gel (D_4) followed by shade drying (D_2) with 122.44 mg/100g dry weight while significantly lowest retention of anthocyanin 63.12 mg/100g dry weight was found in vacuum drying (D_3).
- Embedded drying with silica gel (D_4) preserved significantly highest amount of total carotenoids (11.75 mg/100g dry weight) followed by shade drying (D_2) with retention of 10.49 mg/100g dry weight and vacuum drying (D_3) retained significantly least total carotenoids (7.98 mg/100g dry weight).
- Ascorbic acid content was significantly highest in shade drying (D_2) with retention of 274.62 mg/100g dry weight followed by 217.87 mg/100g dry exhibited by embedded drying with silica gel (D_4) whereas, significantly least ascorbic acid retention was 137.22 mg/100g dry weight as observed in sun drying (D_1)
- Shade drying (D_2) showed significantly best total antioxidant activity with mean score 47.95%. Embedded drying with silica gel (D_4) secured second position with the mean score 44.49% while vacuum drying (D_3) showed significantly least 43.3% of total antioxidant activity.
- Sun drying (D_1) resulted in significantly highest total soluble sugars (5.16%) followed by shade drying (D_2)

with 4.52%. Vacuum drying (D_3) had significantly least total soluble sugars 3.46%.

5.2 Effect of varieties on aesthetic and phytochemical parameters of chrysanthemum flowers

- Dolly White (V_1) was found significantly highest in flower colour retention (mean score 6.74) whereas, Pacho (V_2) showed significantly lowest flower colour retention (mean score 5.72).
- In terms of flower shape also Dolly White (V_1) showed significantly highest efficacy with mean score 6.58 while Pacho (V_2) was found to have significantly lowest mean score 5.49.
- Pacho (V_2) exhibited significantly lowest score for flower brittleness (5.81) indicating increased brittleness while Dolly White (V_1) showed significantly highest mean score for flower brittleness (6.66) showing least brittle flower.
- Flower intactness was found to be significantly highest in Dolly White (V_1) with mean score of 6.65. Sunil (V_5) exhibited significantly lowest score 5.90.
- Dolly White (V_1) was observed to have smoothest texture with significantly highest mean score 6.58 while Pacho (V_2) and Sunil (V_5) were found to be significantly lowest with coarsest textures (5.74 and 5.75 respectively).
- As observed in all other parameters Dolly White (V_1) showed significantly best overall appearance (mean score 6.74) and Pacho (V_2) exhibited significantly lowest score 5.82.
- Dolly White (V_1) was observed to have significantly lowest retention of total phenols (963 mg/100g dry weight) however, Flirt (V_6) showed significantly highest concentration of total phenols (2513 mg/100g dry weight).
- In terms of total flavonoids Flirt (V_6) was again found significantly highest (1664.14 mg/100g dry weight) while Dolly White (V_1) showed significantly lowest result (631.07 mg/100g dry weight).
- Agina Purple (V_3) resulted in significantly highest total anthocyanin retention (225.41 mg/100g dry weight) whereas, Ratlam Selection (V_4) showed significantly lowest total anthocynin retention (20.32 mg/100g dry weight).
- Flirt (V_6) exhibited significantly highest retention of total carotenoids (21.49 mg/100g dry weight) while Sunil (V_5) showed significantly lowest retention of total carotenoids (8.51 mg/100g dry weight).
- Significantly lowest ascorbic acid retention of 104.63 mg/100g dry weight was found in Dolly White (V_1) whereas, Agina Purple (V_6) exhibited significantly highest ascorbic acid retention of 282.08 mg/100g dry weight.
- Total antioxidant activity was influenced by variety used showing result of significantly highest total antioxidant activity in Agina Purle (V_3) with mean score 51.46% and significantly lowest total antioxidant activity in Ratlam Selection (V_4) with score 39.54%.
- Significantly highest total soluble sugars (5.60%) was found in Pacho (V_2) however, significantly lowest total soluble sugars (2.71%) was found in Dolly White (V_1).

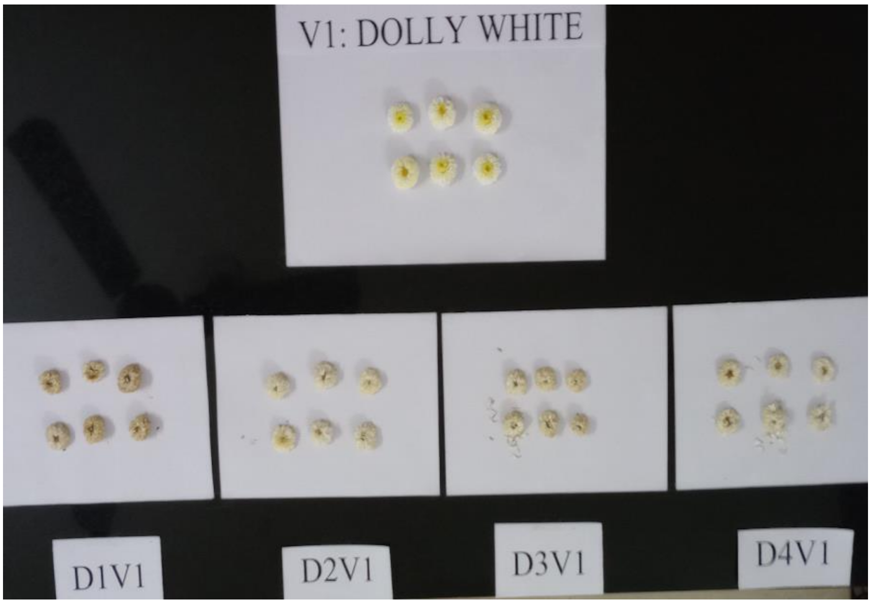
5.3 Interaction effect of drying techniques and varieties on aesthetic and phytochemical parameters of chrysanthemum flowers

- The interaction effect of dehydration technique was found to be significant in terms of flower colour. Shade drying with Dolly White (D_2V_1) showed significantly highest retention with scores 7.92 while vacuum drying with Ratlam Selection (D_3V_4) and vacuum drying with Sunil (D_3V_5) resulted in the significantly poorest with score 4.25 and 4.32 respectively.
- Flower shape was also significantly influenced by the interaction effect of dehydration technique and varieties of chrysanthemum where embedded drying (silica gel) with Pacho (D_4V_2) best preserved flower shape with significantly highest score 7.94 whereas, vacuum drying with Sunil (D_3V_5) led to the most distortion with significantly lowest score of 3.94.
- Flower brittleness of chrysanthemum flowers after drying depended on both the drying technique used and the flower variety. Pacho variety (D_4V_2) was least brittle when shade-dried with significantly highest score of 8.04. However, Sunil (D_3V_5) with vacuum drying and Pacho with shade drying (D_2V_4) became most brittle with significantly lowest score 4.91 for both.
- Embedded drying (silica gel) with Pacho (D_4V_2) and shade drying with Dolly White (D_2V_1) best preserved flower intactness with significantly highest score of 7.90 and 7.86 respectively whereas, vacuum drying with Sunil (D_3V_5) and sun drying with Agina Purple (D_1V_3) led to the most distortion with significantly lowest scores of 4.84 and 5.04 respectively.
- The resulting flower texture of dried chrysanthemum was significantly influenced by the combination of the dehydration technique and variety. Embedded drying (silica gel) with Pacho (D_4V_2), shade drying of Dolly White (D_2V_2) and shade drying of Ratlam Selection (D_2V_4) yielded the significantly most desirable textures scoring 8.06, 7.86 and 7.86 respectively. In contrast, vacuum drying of Sunil (D_3V_5) resulted in significantly least appealing textures with score of 4.46.
- The combined effect of the dehydration technique and chrysanthemum variety significantly impacted the final overall appearance. Embedded drying (silica gel) with Pacho (D_4V_2) and shade drying with Dolly White (D_2V_1) resulted in significantly best overall appearance scoring 8.0 and 7.93 respectively. Conversely, vacuum drying with Sunil (D_3V_5) and shade drying with Pacho (D_2V_2) led to significantly least appealing overall appearance with scores of 4.73 and 4.93 respectively.
- Specific dehydration technique and chrysanthemum variety combinations were most effective in preserving the total phenols i.e. embedded drying (silica gel) for Flirt (D_4V_6) yielded significantly highest levels 2794 mg/100g dry weight. Conversely, vacuum drying with Dolly White (D_3V_1) led to the greatest loss of total phenols with significantly lowest value (781 mg/100g dry weight).
- Regarding total flavonoids the most effective combination was embedded drying (silica gel) applied to Flirt (D_4V_6) variety resulting in the significantly highest retention at 2167 mg/100g dry weight. Conversely, vacuum drying of the Dolly White (D_3V_1)

- variety led to the greatest loss of total flavonoids with levels significantly dropping to 113 mg/100g dry weight.
- The choice of dehydration technique and chrysanthemum variety significantly impacted the preservation of total anthocyanin. Notably, embedded drying using silica gel with Agina Purple (D_4V_3) variety proved most effective resulting in significantly highest total anthocyanin 254.07 mg/100g dry weight. Conversely, applying vacuum drying to Ratlam Selection (D_3V_1) variety led to the most substantial loss of leaving significantly least amount of total anthocyanin (13.92 mg/100g dry weight).
- The effectiveness of total carotenoids preservation in chrysanthemums varied considerably depending on the dehydration techniques and varieties. The most successful approach was embedded drying using silica gel on Flirt (D_4V_6) variety which maintained significantly highest total carotenoids at 25.95 mg/100g dry weight. However, sun drying of Sunil (D_3V_5) variety was proved the least effective leading to significantly lowest content of 4.04 mg/100g dry weight.
- Shade drying (silica gel) with Agina Purple (D_4V_3) best preserved ascorbic acid with significantly highest retention of 389.87 mg/100g dry weight and vacuum drying with Dolly White (D_3V_1) resulted in the greatest loss with significantly least retention (64.21 mg/100g dry weight).
- The preservation of total antioxidant activity was significantly influenced by both the dehydration technique and chrysanthemum variety. Specifically, shade drying with the Agina Purple (D_2V_3) variety proved most effective yielding significantly highest total antioxidant activity of 53.48%. In contrast, applying vacuum drying with Ratlam Selection (D_3V_4) variety resulted in significant loss leaving only 36.88%.
- Optimal preservation of total soluble sugars with significantly highest retention 6.44% was achieved through sun drying of Pacho (D_1V_2) and least effective retention was found in embedded drying (silica gel) of Dolly White (D_4V_1) variety which resulted in the significantly lowest total soluble sugars (1.93%).

Discussion

Findings were consistent with prior studies by Dahiya *et al.* (2002) [5] and Bhalla and Sharma (2002) [3] who emphasized the superior preservation capacity of silica gel. Shade drying ranked second in effectiveness attributed to its moderate drying environment that mitigates pigment degradation and structural collapse as also noted by Jangyukala *et al.* (2022) [7]. Clear varietal differences were also observed supporting earlier findings by Emongor (2007) [6] and Kazaz *et al.* (2009) [8]. Interaction effects between dehydration method and variety were also significant supporting the concept of variety-specific dehydration optimization as proposed by Lewicki (1998) [12] and Abbaspour-Gilandeh *et al.* (2015) [1]. Phytochemical retention was highest under embedded drying as confirmed by Li *et al.* (2019) [13], Chandana *et al.* (2021) [4] and Lu *et al.* (2020) [14]. Shade drying also proved beneficial in maintaining ascorbic acid and antioxidant capacity aligning with findings by Ndawula (2007) [15] and Yahia and Cortes-Penela (2003) [18]. Varietal phytochemical variability was also observed which aligned with the findings of Kundu and Panwar (2018) [10] and Patil *et al.* (2024) [16]. Chromatographic profiling revealed distinct pigment bands across varieties and treatments validating prior pigment group identifications by Lavanya *et al.* (2018) [11], Kim *et al.* (2008) [9] and Alam (2019) [2]. In conclusion, the study affirms that strategically matching dehydration techniques with chrysanthemum varietal traits is essential for maximizing the aesthetic and phytochemical quality of dried chrysanthemum flowers.



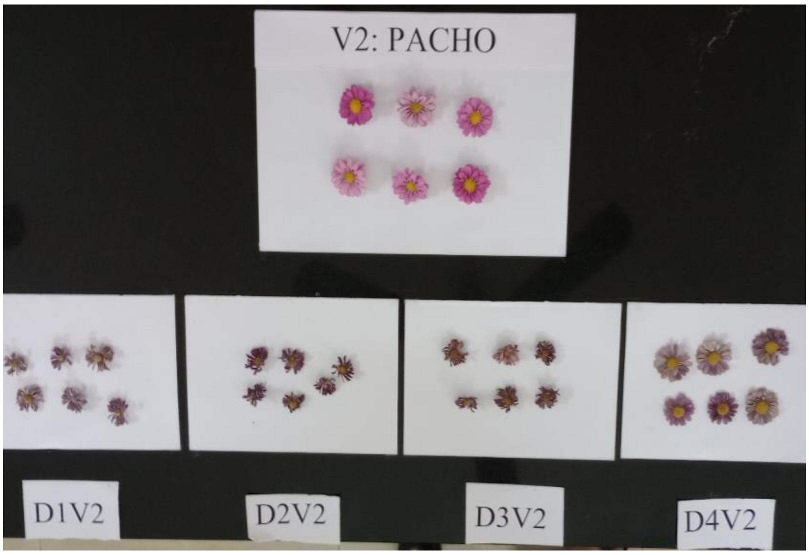


Fig 1: Effect of dehydration techniques and varieties (Dolly White, Pacho and Agina Purple) of chrysanthemum on aesthetic parameters

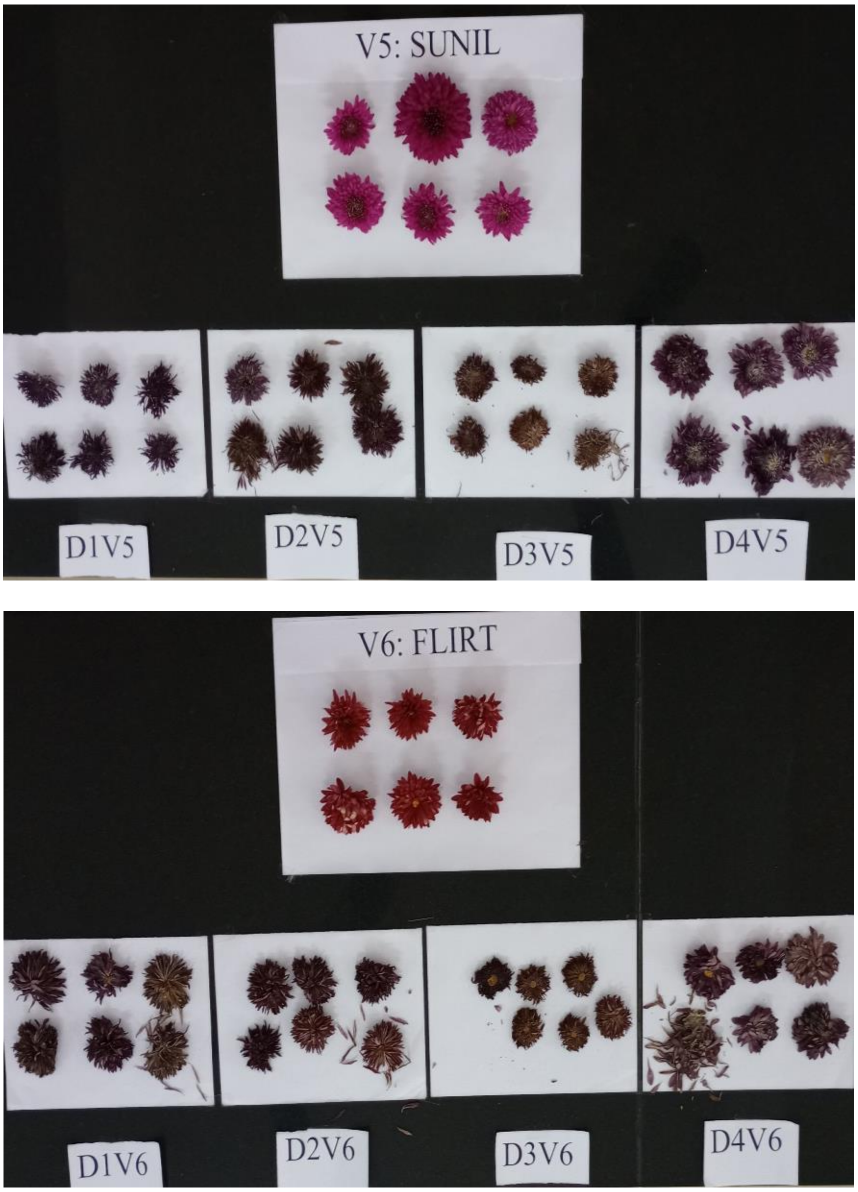


Fig 2: Effect of dehydration techniques and varieties (Ratlam Selection, Sunil and Flirt) of chrysanthemum on aesthetic parameters

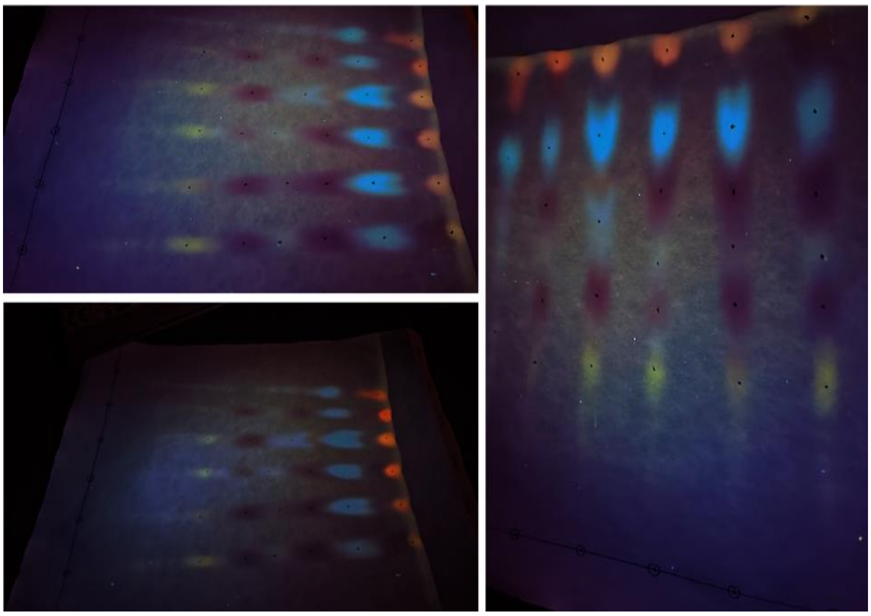


Fig 3: Effect of dehydration techniques and varieties on chromatographic analysis of chrysanthemum pigment profile

Table 1: Effect of dehydration techniques and varieties on aesthetic parameters chrysanthemum

Treatment	Flower Colour (Adhoc Scale)	Flower Shape (Adhoc Scale)	Flower Brittleness (Adhoc Scale)	Flower Intactness (Adhoc Scale)	Flower Texture (Adhoc Scale)	Overall Appearance (Adhoc Scale)
Drying technique						
D_1: Sun Drying	5.52	5.47	5.62	5.74	5.59	5.69
D_2: Shade Drying	6.62	6.58	6.62	6.54	6.63	6.72
D_3: Vacuum Drying	5.16	5.10	5.53	5.60	5.24	5.52
D_4: Silica Gel Drying	7.11	7.06	6.93	6.80	7.05	7.26
SEm ±	0.04	0.03	0.50	0.04	0.04	0.04
CD (0.05)	0.11	0.10	0.13	0.11	0.11	0.12
Variety						
V_1: Dolly White	6.74	6.58	6.66	6.65	6.58	6.74
V_2: Pacho	5.72	5.49	5.81	5.97	5.74	5.82
V_3: Agina Purple	6.27	6.33	6.39	6.28	6.36	6.49
V_4: Ratlam Selection	5.94	6.11	6.20	6.20	6.31	6.37
V_5: Flirt	5.76	5.71	5.99	5.90	5.75	5.92
V_6: Sunil	6.20	6.09	6.01	6.00	6.03	6.45
SEm ±	0.05	0.04	0.60	0.05	0.05	0.05
CD (0.05)	0.14	0.12	1.16	0.13	0.15	0.15
INTERACTION	S	S	S	S	S	S
CV%	2.73	2.40	3.22	2.64	3.06	2.85

Table 2: Effect of dehydration techniques and varieties on phytochemical parameters chrysanthemum

Treatment	Total Phenol mg/100g	Total Flavonoid mg/100g	Total Anthocyanin mg/100g	Total Carotenoid mg/100g	Ascorbic Acid mg/100g	Total Soluble Sugars %	Antioxidant Activity (FRAP) %
Drying Technique							
D_1: Sun Drying	1639	930	114.96	10.84	137.22	5.16	44.49
D_2: Shade Drying	1961	1073	122.44	11.76	274.62	4.52	47.95
D_3: Vacuum Drying	1460	768	63.12	15.16	170.28	4.08	43.13
D_4: Silica Gel Drying	2256	1439	133.60	17.03	217.87	3.46	46.54
SEm ±	23.76	4.03	0.34	0.06	2.25	0.01	0.14
CD (0.05)	67.55	11.45	0.97	0.18	6.40	0.03	0.39
Variety							
V_1: Dolly White	963	248	24.46	13.66	104.63	2.71	50.35
V_2: Pacho	1744	901	50.73	18.21	222.74	5.60	45.89
V_3: Agina Purple	2366	1532	225.41	11.21	282.08	3.47	51.46
V_4: Ratlam Selection	1371	638	20.32	9.10	126.71	5.21	39.54
V_5: Flirt	2014	1151	174.43	8.51	266.31	4.67	41.92
V_6: Sunil	2513	1846	155.82	21.49	197.51	4.19	44.01
SEm ±	29.10	4.93	0.42	0.08	2.76	0.02	0.17
CD (0.05)	82.74	14.03	1.19	0.23	7.84	0.05	0.47
INTERACTION	S	S	S	S	S	S	S
CV%	1.84	1.62	1.34	2.01	4.78	1.29	1.27

Table 3: Interaction effect of dehydration techniques and varieties on aesthetic and phytochemical parameters chrysanthemum

Parameters	Phytochemical							Asthetic (sensory evaluation: adhoc scale)					
Treatment	Phenol (mg/100g)	Flavonoid (mg/100g)	TSS (%)	Ascorbic Acid (mg/100g)	Anthocyanin (mg/100g)	Carotenoid (mg/100g)	Antioxidant (%)	Colour	Shape	Brittleness	Intactness	Texture	Overall Appearance
D_1V_1	854	195	3.35	77.97	24.95	11.98	49.94	5.73	5.73	6.33	6.8	6.13	5.8
D_1V_2	1366	690	6.44	163.97	44.64	15.47	45.25	4.8	4.67	4.93	5.27	4.93	4.93
D_1V_3	2168	1414	4.21	192.64	252.12	9.34	50.44	5.53	5.6	5.33	5.07	5.4	5.47
D_1V_4	1167	574	6.33	112.37	19.26	6.38	38.15	4.87	5.2	5.27	5.2	5.33	5.27
D_1V_5	1813	924	5.76	146.77	179.39	4.04	40.3	5.27	5.13	5.2	5.67	4.87	4.87
D_1V_6	2464	1783	4.88	129.57	169.38	17.85	42.84	6.6	6.4	6.4	6.6	6.53	6.6
D_2V_1	901	295	3.1	158.24	24.52	10.7	52.6	7.87	7.8	7.67	7.67	7.8	7.73
D_2V_2	2006	1030	5.69	318.77	51.25	15.97	47.66	5.47	4.4	4.87	5.33	4.93	4.73
D_2V_3	2517	1401	3.71	389.87	251.02	9.21	53.49	6.4	6.8	6.8	6.67	6.6	6.53
D_2V_4	1551	656	5.44	181.17	21.55	7.25	42.21	7.53	7.8	7.6	7.6	7.8	7.73
D_2V_5	2207	1145	4.77	366.93	203.15	7.47	44.49	6	6.33	6.4	6.07	6.07	6.07
D_2V_6	2581	1912	4.43	232.77	183.13	19.97	47.28	6.13	6.27	6.13	6.07	6.2	6.33
D_3V_1	781	113	2.45	64.21	20.2	14.79	48.04	6.13	6.2	5.93	5.87	6.07	6
D_3V_2	1205	640	5.32	158.24	32.08	18.92	43.6	5.2	4.93	5.27	5.47	4.87	5
D_3V_3	2017	1177	3.25	261.44	144.43	11.52	49.18	5.73	5.73	6.07	6.13	5.67	5.8
D_3V_4	955	321	4.99	83.71	13.92	12.05	36.88	4.2	4.6	5.27	5.6	5.2	5.07
D_3V_5	1586	835	4.46	267.17	100.73	11.5	39.67	4.27	3.93	4.87	4.87	4.4	4.53

D_3V_6	2213	1522	4.03	186.91	67.38	22.17	41.44	5.13	5.13	5.53	5.87	4.87	5.47
D_4V_1	1317	390	1.93	118.11	28.17	17.18	50.82	7	6.53	6.53	6.4	6.07	6.6
D_4V_2	2397	1243	4.94	249.97	74.93	22.48	47.02	7.2	7.93	8	7.93	8	7.8
D_4V_3	2763	2136	2.71	284.37	254.07	14.76	52.72	7.2	7.13	7.2	7.4	7.53	7.33
D_4V_4	1812	1001	4.07	129.57	26.56	10.73	40.94	6.93	6.8	6.47	6.53	6.67	6.6
D_4V_5	2451	1698	3.7	284.37	214.44	11.05	43.22	7.27	7.4	7.33	7.13	7.4	7.4
D_4V_6	2794	2167	3.43	240.8	203.41	25.95	44.49	6.73	6.53	5.8	5.6	6.27	6.6
SEm ±	19.40	9.87	0.01	5.51	0.84	0.16	0.33	0.10	0.08	0.11	0.09	0.11	0.10
CD $_{(0.05)}$	55.16	28.05	0.03	15.69	2.38	0.45	0.95	0.27	0.24	0.33	0.27	0.31	0.29
CV %	1.84	1.62	1.29	4.78	1.34	2.01	1.27	2.73	2.40	3.22	2.64	3.06	2.85

Conclusion

Forgoing research results revealed that embedded drying with silica gel provided significantly higher preservation of all aesthetic parameters and most phytochemicals except ascorbic acid, antioxidant activity and total soluble sugars. Shade drying exhibited significantly highest retention of ascorbic acid and antioxidant activity while sun drying resulted in significantly highest retention of total soluble sugars. Regarding varieties Dolly White exhibited significantly highest result in all aesthetic parameters while Flirt was observed significantly highest in total phenols, total flavonoids and total carotenoids. Agina Purple showed significantly highest anthocyanin, ascorbic acid content and antioxidant activity. Significantly highest total soluble sugars was found in Pacho. Interactive effects were also observed for all studied parameters indicating embedded drying (silica gel) with Pacho best preserved all other aesthetic parameters except flower colour while embedded drying of Flirt yielded the highest total phenols, total flavonoids and total carotenoids. Shade drying of Agina Purple best preserved ascorbic acid and antioxidant activity.

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