Standardization of drying techniques of Dahlia, Larkspur and China Aster

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ABSTRACT

The present experiment was carried out to standardize drying methods for Dahlia, Larkspur and China Aster and to assess the influence of drying and storage methods on storage quality of the dried flowers. Flowers of Dahlia, Larkspur and China Aster were subjected to seven different drying methods *viz.*, shade drying method without embedding medium (T_1), with sand embedding (T_2) and with silica gel embedding (T_3), microwave oven drying with sand (T_4) and silica gel embedding (T_5), hot air oven drying at 45^0C with sand (T_6) and silica gel embedding (T_7) and stored in cardboard and plastic boxes for three months. Data were statistically analyzed in Completely Randomized Design. The results indicated that in Dahlia, maximum moisture loss (88.25 %) and maximum per cent retention of perimeter (95.28) was observed in T_7. In Larkspur, maximum moisture loss (73.43 %) was observed in T_1 and maximum percent retention of perimeter (89.62 %) was observed in T_4. In China Aster, maximum moisture loss (89.10 %) was observed in T_5 and maximum percent retention of perimeter (95.29%) was observed in T_6. Time taken for drying was found minimum in silica embedded drying in microwave oven in Dahlia (0.00208 days), Larkspur (0.00139 days) and China Aster (0.00278 days) while, shade dried flowers took maximum time to dry in Dahlia (14.0 days), Larkspur (12.0 days) and in China Aster (15.0 days). Maximum quality score on visual basis of color, appearance, texture and shattering of petals in dried flowers of Dahlia (15.73) was observed in T_7, in T_4 for Larkspur (15.63) and in T_6 for China Aster (15.51). After 90 days of storage, minimum color fading in Dahlia, Larkspur and China aster was observed in flowers stored in plastic boxes while there was no incidence of pests or diseases observed during storage.

Keywords: Drying methods, embedding medium, storage methods, sensory evaluation

1. INTRODUCTION

Flowers have always remained an innate part of human life. They are an integral part of mankind and almost every occasion, from welcoming to funeral, wedding and various ceremonies have involvement of flowers. Fresh flowers though exquisite in their beauty, can be quite expensive and are perishable in nature and most flowers are available only for particular seasons. These reasons have led to the popularity of dry flowers among the masses where people want to enjoy blooms all year long as dried flowers are enduring, adds on aesthetics and are available all year round, irrespective of the season [1]. The dehydrated or dried ornamental plant parts are generally inexpensive and are sought for their everlasting and attractive appearance [2]. The art of flower drying is a very age-old practice. Earlier dried flowers were used in the form of herbarium by botanists for the purpose of identification of various species [3]. Though drying of flowers is well known even in the past but for the first time the flowers were dried commercially in Germany [4].

The dry flower industry has become the most promising area in floriculture since the past four decades after it was being initially introduced by British in Calcutta due to its proximity to north east and eastern regions where exotic and various plants were easily accessible [5]. This industry includes not only use of flower but every part of plant that can be dehydrated foliage, seeds, flower, stem etc. The dry Government of India has identified floriculture as a sunrise industry and accorded it 100 % export-oriented status. The country has exported 15,695.31 MT of floriculture products to the world for the worth of Rs. 575.98 Crores/77.84 USD Millions in 2020-2021. The export market of flowers in India is composed of 71% of dry flowers exported mainly to U.S.A, Japan, Australia, Europe and Russia [6]. Demand of dry flower increase at impressive rate of 8 – 10%. This industry shows a growth rate of 15% annually. India is the fifth largest exporter of dry flowers in the world.

Dahlia, Larkspur and China aster are widely grown in India. Dahlia is a tuberous rooted half hardy herbaceous perennial belonging to the family *Compositae.* They have wide range of colors and shapes and are very popular among Indian gardens. Larkspur and China aster make excellent cut flowers and are widely cultivated in many parts of India. Larkspur is a member of the *Delphinium* family and is available in more than 60 varieties. China Aster is also grown for loose flowers, bedding and potting purpose. Though dried flowers are earning better exchange than fresh cut flowers, a number of flowers and ornamentals have not been exploited to produce dry horticultural products among which Dahlia, Larkspur and China Aster are included. There is the need to identify, explore and evaluate native plant species and various ornamentals having potential as dry flowers. The aim of this work was to standardize drying methods of Dahlia, Larkspur and China Aster and to evaluate storage methods of dried flowers of Dahlia, Larkspur and China Aster.

2. MATERIAL AND METHODS

The present investigation was carried out in the laboratory of the Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (UP), during 2021- 2022. For the experiment, healthy, disease free and uniform flowers of Dahlia, Larkspur and China aster were harvested in the morning hours right after evaporation of dewdrops from the plant surface and subjected to seven different drying treatments *viz.*, shade drying method without embedding medium (T_1), with sand embedding (T_2) and with silica gel embedding (T_3), microwave oven drying at with sand (T_4) and silica gel embedding (T_5), hot air oven drying at 45^0C with sand (T_6) and silica gel embedding (T_7). Observations such as reduction in weight, percent moisture loss, time taken to dry, percent reduction in perimeter, percent retention of perimeter were recorded. After drying, quality parameters such as colour, appearance, texture and shattering of petals were assessed by means of sensory evaluation by a panel of ten semi-trained judges 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.

In shade drying method, freshly harvested flowers were tied in bunches and hanged vertically in upside down position in shade in the laboratory. For embedding, powdered silica gel of 120 mesh with blue colour indicator and river sand were used. For embedded drying in shade, plastic trays of 10cm depth were used whereas oven-safe aluminium trays were used for microwave and hot air oven drying methods. An LG Microwave oven with a fixed micropower (900 watt) was used for microwave oven drying. The desiccants were poured up to one inch height in the trays and flowers were inserted in inverted position and then covered with the desiccants by spreading the media evenly so that the petals are completely covered and there is equal pressure on all sides of the flower. After the flowers were dried completely, the trays were tilted to remove the desiccants over and around the flowers. The dried flowers were then picked up by hand, cleaned by inverting them and tapping the stems with the fingers slowly and gently. Any remaining desiccants were then removed with the help of fine and soft brush. The flowers were checked at regular intervals to record the weight loss up to standstill, indicating the completion of the drying process. At the end of the drying process, the petals of the flowers were pressed with fingers to check the presence of moisture. If moisture was still present, then the flowers were further exposed to drying methods for complete elimination of moisture. The data recorded for standardization of drying techniques were analysed as per standard statistical methods for Completely Randomized Design using Microsoft Excel and OPSTAT online statistical analysis software [6].

For storage studies, two storage methods that is cardboard boxes and plastic boxes were used and flowers were stored at ambient temperature in a dark place for three months and interaction effect between drying methods and storage methods were studied. Observations were recorded on extent of color fading on storage and damage of flower due to incidence of pests and diseases *etc.* Panel of ten semi trained judges assessed the parameters viz., colour fading and damage to flower by scoring on a five-point scale given by Safeena [7] *i.e*., very low, low, medium, high and very high 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 by means of sensory evaluation. The data recorded for storage studies was analysed as per standard statistical methods for Factorial Completely Randomized Design using OPSTAT online statistical analysis software [8].

3. RESULTS AND DISCUSSION

3.1 Reduction in weight

Significantly maximum reduction in weight (3.41g) was observed in hot air oven drying with silica gel embedding (T_7) in Dahlia and is presented in table 1. Whereas in Larkspur, maximum reduction in weight (1.16 g) was observed in shade drying method (table 2) and in China Aster, maximum reduction in weight (4.22g) was observed in microwave oven drying with silica gel as embedding medium (table 3). Minimum reduction in weight of the flowers for Dahlia (2.42g), larkspur (0.72g) and China Aster (2.94g) were observed in shade drying with sand embedding method. Sand as an embedding medium without the support of heat resulted in lesser removal of moisture from flowers.

3.2 Moisture content

Significant differences were observed in the moisture content of flowers as affected by different drying methods. Minimum moisture removal was observed in shade drying with sand embedding method for Dahlia (75.72%), Larkspur (62.32%) and China Aster (81.33%) flowers and is depicted in table 1,2 and 3 respectively. This might be due to the large particle size and heavy weight of sand that absorbed less moisture and retained moisture for a short duration which ultimately led to fractional reabsorption by the partly dried tissues. Maximum moisture loss (73.43%) was observed in shade drying in Larkspur. Similar results were observed in Carnation *cv*. Master by Nirmala ***et al*.,** [9]. Whereas maximum moisture loss (88.25%) in Dahlia was observed in T_7 and in T_5 (89.10%) in China Aster flowers. Both microwave oven and hot air oven have been reported to have significant effect on moisture removal of flowers since higher temperature leads to rapid and efficient removal of moisture from the flowers.

3.3 Drying duration

Shade dried flowers of Dahlia, Larkspur and China Aster took maximum time to dry (14, 12 and 15 days respectively) and yield a medium quality of produce. Since shade drying depends greatly on relative humidity and room temperature, the low ambient room temperature and relative humidity were inadequate to dry the flowers quickly. Microwave oven drying with silica gel embedding method was found to be the fastest method of drying for Dahlia (0.00208 days), Larkspur (0.00139 days) and China aster (0.00278 days) respectively. This is due strong hygroscopic nature of silica gel combined with higher temperature of the microwave oven which increase the rate of transpiration. 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 and thus act as a dehydrating agent as also explained by Sindhuja *et al***.,** [10].

3.4 Retention of flower shape

There was maximum reduction in perimeter for all the three flowers in shade drying method. This was because there was no embedding medium to support and hold the petals in place as moisture gets removed from the surface of the flowers combined with low room temperature which takes longer time for drying and results in more shrinkage of petals. Shrivelling of flowers and withering of petals are most commonly observed in this method. Similarly slow rate of drying and shrinking of petals under shade was reported by Aravinda [11] and Hemant *et al*., [12]. Maximum retention of perimeter for Dahlia (95.28%) was observed in T_7. Previous studies have shown that sand and silica gel are comparatively good desiccants to maintain the original shape of the flower (table 1). Safeena *et al*.,[13] reported that silica gel as embedding material prevents the shrinkage of flower petals. The efficacy of silica gel as embedding material in hot air oven was also reported by Lalhruaitluangi and Khawlhring [14] in Rose and Sudeep *et al*., [15] in Orchid. For Larkspur, maximum percent retention of the perimeter was observed in sand embedded drying in microwave oven (89,62%), and hot air oven (86.99%) and is depicted in table 2. While, in China Aster, maximum percent retention of the perimeter was observed in sand embedded drying in hot air oven (95.29%), and microwave oven (92.85%) and is depicted in table 3. This may be due to the fact that sand does not react with water vapour released during the process of drying. It allows the water vapour to escape in to the air freely thereby causing minimum loss in size of flowers as explained by Sindhuja *et al.*, [10].

3.5 Visual quality parameters

The effect of different drying methods on qualitative characteristics of Dahlia, Larkspur and China Aster flowers is depicted in Table 4. Drying techniques except shade drying showed highly acceptable flower qualities. In Dahlia, highest quality score for colour (3.90), texture (3.88), appearance (3.96) and no shattering of petals was observed when flowers were embedded in silica gel in hot air oven. In China Aster, maximum score for colour (4.0), texture (3.79), appearance (3.90) and no shattering of petals was observed when flowers were embedded in sand in hot air oven. This may be due to the uniform temperature maintained inside the hot air oven which facilitated rapid, uniform and gradual removal of moisture from the flowers. Hence it avoids severe dehydration and shrivelling of flowers. This helps in obtaining better quality dry flowers. Highest score for colour (3.90), texture (3.88), appearance (3.96) and no shattering of petals for Larkspur flowers was observed when flowers were dried in microwave oven with sand as embedding medium. Meman *et al*.,[16] observed brighter colored flowers when embedded in sand as a medium. Singh [17] had also reported that colour retention and texture of many flowers was better maintained in sand and silica gel. In the present study also, sand embedding in microwave and hot air oven has been found to give the best quality dry flowers for Larkspur and China Aster while silica gel embedding in microwave oven gave best quality dry Dahlias. Similarly, Prasad *et al.*, [3] reported that Rose flowers appeared almost fresh when dried in silica gel, although the colour darkened. He also stated that colours that came out close to the original when dried in silica gel are white, yellow, and lavender. Darker colours such as red, deep pink and orange tend to turn even darker.

3.6 Colour fading in storage

One of the main reasons besides many other useful qualities for the production of dried flowers is to fill the glut in the market when seasonal fresh flowers are unavailable. Flowers are dried during production season so they could be stored to meet a glut in the market hence these dried flowers have to be maintained and protected from various conditions that could destroy their qualities. Dried flowers tend to reabsorb moisture and lose their quality during storage if proper steps and measures are not taken to prevent these problems. Therefore, selection of suitable packaging and storage methods are very important to enhance the shelf life of dried flowers. Data pertaining to colour fading in Dahlia, Larkspur and China Aster flowers under different conditions of storage as assessed through sensory evaluation after 30, 60 and 90 days of storage are presented in Table 5, 6 and 7 respectively. Interaction effect of drying methods and storage conditions had a significant effect on colour fading of dried flower colour. Highest score (3.21) after 90 days for Dahlia flowers was recorded in treatment combination with (M_7S_2) i.e., hot air oven with silica gel embedding + plastic boxes. In Larkspur, highest score (2.93) after 90 days was observed in microwave oven drying with sand embedding + plastic boxes. In China Aster, highest score (3.15) was observed in hot air oven drying with sand embedding + plastic boxes. Gouin [18] also stated that dried materials should be stored in a dark, dry airtight container to prevent them from absorbing water during humid periods and also to prevent dust from sticking and discoloration of the petals. The efficacy of plastic boxes as storage for dried flowers were also reported in Dendrobium orchid by Salma *et al*., [19]. Minimum score was observed in shade dried flowers stored in cardboard boxes for Dahlia, Larkspur and China Aster. This may be due to the reabsorption of moisture from atmosphere when flowers were stored in cardboard boxes and also the colour fading that occurs due to change during isomerization and oxidation of pigments, especially anthocyanin, and carotenoids and formation of phenolic compounds, which impart brown coloration in the flowers [20].

3.7 Damage to flower due to incidence of pests and diseases etc.

There was no incidence of pest and diseases that occurred during storage as influenced by drying methods, storage methods and their interactions. This may be due to proper removal of moisture from the flowers as well as favourable climatic and storage conditions that inhibits the growth of microbes and prevent insect attack.

4. CONCLUSION

- For dahlia (T_7) i.e., hot air oven drying with silica gel as embedding medium gives the best quality dried flowers which was on par with (T_5) i.e., microwave oven drying with silica gel as embedding medium.
- For larkspur, (T_4) i.e., microwave oven drying with sand as embedding medium gives best results which was on par with (T_6) i.e., hot air oven with sand as embedding medium.
- For China aster, (T_6) i.e., hot air oven at with sand as embedding medium provide the best results which was on par with (T_4) i.e., microwave drying with sand as embedding medium.

- Storage of flowers in plastic boxes was found to be better than cardboard boxes in terms of color fading on up to three months storage.
- There was no incidence of pest and diseases that occur during storage as influenced by drying methods, storage methods and their interactions.

Table 1. Changes in weight of flowers, duration of drying and perimeter of Dahlia flowers as influenced by different drying methods

Treatment	Final weight of the flowers (g)	Reduction in total weight of flowers (g)	Duration required for drying of flowers (days)	Loss of moisture content(%)	Final perimeter of flowers (cm)	Reduction in perimeter of flowers (cm)	Percent reduction of perimeter %	Percent retention of perimeter %
T_1	0.5	3.38	14	86.26	18.8	9.19	32.53	67.47
T_2	0.76	2.42	12	75.72	25.59	3.75	12.47	87.53
T_3	0.51	2.43	6.5	82.42	25.06	2.65	9.36	90.64
T_4	0.74	2.73	0.002778	77.52	27.45	2.21	7.47	92.53
T_5	0.68	2.66	0.001389	79.11	27.69	2.13	6.96	93.04
T_6	0.62	2.83	3	81.75	27.06	3.79	12.57	87.43
T_7	0.44	3.41	2.5	88.25	28.08	1.4	4.72	95.28
F-test	S	S	S	S	S	S	S	S
SE(d)±	0.101	0.145	0.13	0.057	1.123	0.995	0.035	0.035
CV	20.448	6.256	2.935	3.922	5.359	33.945	34.624	4.85
C.D. @ 5%	0.22	0.314	0.282	0.057	2.433	2.155	0.075	0.075

Table 2. Changes in weight of flowers, duration of drying and perimeter of Larkspur flowers as influenced by different drying methods

Treatment	Final weight of the flowers (g)	Reduction in total weight of flowers (g)	Duration required for drying of flowers (days)	Loss of moisture content(%)	Final perimeter of flowers (cm)	Reduction in perimeter of flowers (cm)	Percent reduction of perimeter %	Percent retention of perimeter %
T_1	0.33	1.16	12	73.43	6.34	3.6	35.07	64.93

T_2	0.61	1.01	9	62.32	9.39	2.25	18.92	81.08
T_3	0.58	1.13	5.3	64.36	9.51	1.63	14.56	85.44
T_4	0.35	0.72	0.002083	67.83	9.92	1.13	10.38	89.62
T_5	0.36	0.74	0.001389	65.56	8.79	1.44	13.83	86.17
T_6	0.39	0.81	2.4	66.66	9.42	1.42	13.01	86.99
T_7	0.36	0.82	1.4	65.69	8.81	1.55	14.48	85.52
F-test	S	S	S	S	S	S	S	S
SE(d)±	0.045	0.097	0.092	0.011	0.408	0.497	0.042	0.042
CV	12.547	13.059	2.457	1.999	5.568	34.37	31.207	6.13
C.D. @ 5%	0.096	0.211	0.2	0.024	0.883	1.076	0.091	0.091

Table 3. Changes in weight of flowers, duration of drying and perimeter of China Aster flowers as influenced by different drying methods

Treatment	Final weight of the flowers (g)	Reduction in total weight of flowers (g)	Duration required for drying of flowers (days)	Loss of moisture content(%)	Final perimeter of flowers (cm)	Reduction in perimeter of flowers (cm)	Percent reduction of perimeter %	Percent retention of perimeter %
T_1	0.63	3.11	15	82.39	12.75	2.4	16.33	83.67
T_2	0.66	2.94	11	81.33	15.3	1.66	9.72	90.28
T_3	0.58	3.49	5	85.18	13.36	2.34	14.73	85.27
T_4	0.62	3.3	0.003473	83.96	16.03	1.25	7.16	92.84
T_5	0.5	4.22	0.002779	89.1	14.83	1.59	9.89	90.11
T_6	0.53	3.56	4	86.4	17.02	0.84	4.71	95.29
T_7	0.51	3.92	3	88.15	14.61	2.33	13.63	86.37
F-test	S	S	S	S	S	S	S	S
SE(d)±	0.046	0.349	0.087	0.015	0.871	0.416	0.025	0.025
CV	9.781	12.198	2.006	2.224	7.191	28.762	28.677	3.501
C.D. @ 5%	0.1	0.756	0.188	0.034	1.887	0.901	0.055	0.055

Table 4: Effect of different drying methods on qualitative characteristics of Dahlia, Larkspur and China Aster flowers

	Dahlia				Larkspur				China Aster			
Treatment	Colour	Appearance	Texture	Shattering of petals	Colour	Appearance	Texture	Shattering of petals	Colour	Appearance	Texture	Shattering of petals
T_1	1.62	0.24	0.24	1.48	1.17	0.39	0.22	0.2	1.41	0.23	0.18	0.7
T_2	2.57	2	2.01	2.51	3.61	3.79	3.69	3.69	3.31	2.39	3.05	3.13
T_3	3.11	3.83	3.9	3.32	3.74	3.33	3.67	3.37	3.27	3.23	2.45	2.9
T_4	3.2	3.1	3.51	3.68	3.9	3.96	3.88	3.89	3.93	3.75	3.57	3.71
T_5	3.78	3.91	3.82	3.83	3.52	3.79	3.55	3.75	3.81	3.72	3.54	3.43
T_6	3.36	3.3	3.41	3.51	3.83	3.93	3.85	3.8	4	3.9	3.79	3.82
T_7	3.89	4.01	3.91	3.92	3.6	3.4	3.69	3.71	3.33	3.51	3.16	3.1
F-test	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)±	0.115	0.066	0.087	0.086	0.07	0.087	0.102	0.14	0.063	0.067	0.121	0.134
CV	4.527	2.784	3.527	3.305	2.561	3.311	3.863	5.357	2.251	2.768	5.253	5.511
C.D. @ 5%	0.246	0.143	0.189	0.186	0.151	0.189	0.22	0.303	0.137	0.145	0.262	0.289

Treatment details

T_1- Shade drying
T_2- Shade drying with sand as embedding medium
T_3- Shade drying with silica gel as embedding medium
T_4- Microwave oven drying with sand as embedding medium
T_5- Microwave oven drying with silica gel as embedding medium
T_6- Hot air oven drying with sand as embedding medium
T_7- Hot air oven drying with silica gel as embedding medium

Table 5: Effect of drying methods, storage methods and their interactions on extent of colour fading during storage of Dahlia flowers.

Treatments		Color fading		
Drying methods (M)		**30 Days**	**60 Days**	**90 Days**
M_1	Shade drying	2.57	2.24	2.02
M_2	Shade drying with sand as embedding medium	3.19	2.46	2.18
M_3	Shade drying with silica gel as embedding medium	3.5	2.85	2.55
M_4	Microwave oven drying with sand as embedding medium	3.13	2.88	2.36
M_5	Microwave oven drying with silica gel as embedding medium	3.5	3.01	2.87
M_6	Hot air oven drying with sand as embedding medium	3.32	2.98	2.68
M_7	Hot air oven drying with silica gel as embedding medium	3.62	3.35	3.11
SE(d) ±		0.224	0.059	0.046
CD		0.46	0.122	0.094
Storage methods (S)				
S_1	Cardboard boxes	3.18	2.65	2.45
S_2	Plastic boxes	3.35	3	2.63
SE(d) ±		0.12	0.032	0.024
CD		NS	0.065	0.05
Interaction (M x S)				
M_1S_1	Shade drying + Cardboard boxes	2.53	2.14	2
M_1S_2	Shade drying + Plastic boxes	2.6	2.33	2.03
M_2S_1	Shade drying with sand embedding + Cardboard boxes	3.1	2.45	2.15
M_2S_2	Shade drying with sand embedding + Plastic boxes	3.28	2.47	2.22
M_3S_1	Shade drying with silica gel embedding + Cardboard boxes	3.4	2.62	2.32
M_3S_2	Shade drying with silica gel embedding + Plastic boxes	3.6	3.08	2.78
M_4S_1	Microwave oven drying with sand embedding + Cardboard boxes	3	2.61	2.31
M_4S_2	Microwave oven drying with sand embedding + Plastic boxes	3.27	3.15	2.42
M_5S_1	Microwave oven drying with sand embedding + Cardboard boxes	3.43	2.72	2.85
M_5S_2	Microwave oven drying with sand embedding + Plastic boxes	3.57	3.3	2.89
M_6S_1	Hot air oven drying with sand embedding + Cardboard boxes	3.23	2.82	2.52
M_6S_2	Hot air oven drying with sand embedding + Plastic boxes	3.4	3.14	2.84
M_7S_1	Hot air oven drying with silica gel embedding + Cardboard boxes	3.53	3.19	3
M_7S_2	Hot air oven drying with silica gel embedding + Plastic boxes	3.7	3.51	3.21
SE(d) ±		0.317	0.084	0.065
CD		NS	0.173	0.133

Table 6: Effect of drying methods, storage methods and their interactions on extent of colour fading during storage of Larkspur flowers.

Treatments		Color fading		
Drying methods (M)		**30 Days**	**60 Days**	**90 Days**
M_1	Shade drying	3.22	2.12	2.08
M_2	Shade drying with sand as embedding medium	3.56	2.33	2.51
M_3	Shade drying with silica gel as embedding medium	3.62	2.48	2.29
M_4	Microwave oven drying with sand as embedding medium	3.8	3.22	2.79
M_5	Microwave oven drying with silica gel as embedding medium	3.44	2.34	2.25
M_6	Hot air oven drying with sand as embedding medium	3.65	3.02	2.61
M_7	Hot air oven drying with silica gel as embedding medium	3.55	2.43	2.46
SE(d) ±		0.187	0.042	0.093
CD		NS	0.087	0.191
Storage methods (S)				
S_1	Cardboard boxes	3.46	2.4	2.25
S_2	Plastic boxes	3.64	2.72	2.61
SE(d) ±		0.1	0.023	0.05
CD		NS	0.047	0.102
Interaction (M x S)				
M_1S_1	Shade drying + Cardboard boxes	3.1	2.1	2.05
M_1S_2	Shade drying + Plastic boxes	3.34	2.13	2.11
M_2S_1	Shade drying with sand embedding + Cardboard boxes	3.44	2.23	2.14
M_2S_2	Shade drying with sand embedding + Plastic boxes	3.68	2.43	2.87
M_3S_1	Shade drying with silica gel embedding + Cardboard boxes	3.56	2.18	2.04
M_3S_2	Shade drying with silica gel embedding + Plastic boxes	3.68	2.78	2.55
M_4S_1	Microwave oven drying with sand embedding + Cardboard boxes	3.75	3.12	2.65
M_4S_2	Microwave oven drying with sand embedding + Plastic boxes	3.85	3.32	2.93
M_5S_1	Microwave oven drying with sand embedding + Cardboard boxes	3.32	2.1	2.07
M_5S_2	Microwave oven drying with sand embedding + Plastic boxes	3.56	2.57	2.43
M_6S_1	Hot air oven drying with sand embedding + Cardboard boxes	3.61	2.8	2.42
M_6S_2	Hot air oven drying with sand embedding + Plastic boxes	3.7	3.23	2.8
M_7S_1	Hot air oven drying with silica gel embedding + Cardboard boxes	3.43	2.31	2.35
M_7S_2	Hot air oven drying with silica gel embedding + Plastic boxes	3.67	2.56	2.57
SE(d) ±		0.265	0.064	0.129
CD		NS	0.131	0.266

Table 7: Effect of drying methods, storage methods and their interactions on extent of colour fading during storage of China Aster flowers.

Treatments		Color fading		
Drying methods (M)		**30 Days**	**60 Days**	**90 Days**
M_1	Shade drying	2.53	2.37	2.07
M_2	Shade drying with sand as embedding medium	2.97	2.81	2.5
M_3	Shade drying with silica gel as embedding medium	2.76	2.59	2.24
M_4	Microwave oven drying with sand as embedding medium	3.37	3.12	2.93
M_5	Microwave oven drying with silica gel as embedding medium	2.97	2.77	2.45
M_6	Hot air oven drying with sand as embedding medium	3.55	3.37	3.04
M_7	Hot air oven drying with silica gel as embedding medium	2.97	2.93	2.66
SE(d) ±		0.052	0.061	0.058
CD		0.107	0.126	0.118
Storage methods (S)				
S_1	Cardboard boxes	2.89	2.74	2.4
S_2	Plastic boxes	3.15	2.96	2.72
SE(d) ±		0.028	0.033	0.031
CD		0.057	0.067	0.063
Interaction (M x S)				
M_1S_1	Shade drying + Cardboard boxes	2.48	2.33	2.01
M_1S_2	Shade drying + Plastic boxes	2.58	2.4	2.13
M_2S_1	Shade drying with sand embedding + Cardboard boxes	2.78	2.61	2.2
M_2S_2	Shade drying with sand embedding + Plastic boxes	3.16	3.01	2.81
M_3S_1	Shade drying with silica gel embedding + Cardboard boxes	2.58	2.42	2.03
M_3S_2	Shade drying with silica gel embedding + Plastic boxes	2.94	2.76	2.45
M_4S_1	Microwave oven drying with sand embedding + Cardboard boxes	3.31	3.1	2.86
M_4S_2	Microwave oven drying with sand embedding + Plastic boxes	3.43	3.13	3
M_5S_1	Microwave oven drying with sand embedding + Cardboard boxes	2.87	2.67	2.32
M_5S_2	Microwave oven drying with sand embedding + Plastic boxes	3.07	2.87	2.57
M_6S_1	Hot air oven drying with sand embedding + Cardboard boxes	3.53	3.33	2.93
M_6S_2	Hot air oven drying with sand embedding + Plastic boxes	3.57	3.41	3.15
M_7S_1	Hot air oven drying with silica gel embedding + Cardboard boxes	2.67	2.72	2.42
M_7S_2	Hot air oven drying with silica gel embedding + Plastic boxes	3.27	3.13	2.9
SE(d) ±		0.074	0.086	0.081
CD		0.152	0.178	0.167

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