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An approach to color preservation of some dehydrated flowers and foliages

M. MALAKAR, P. ACHARYYA AND S. BISWAS

Department of Horticulture, University of Calcutta, Hazra Road, Kolkata- 700019.

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ABSTRACT

The everlasting appetite of eco-friendly natural plant materials to embellish breathing and functioning areas is corroborated. Thus, we have endeavored to preserve the glory and hues of Chrysanthemum morifolium Ramat. (Yellow) and Gaillardia pulchella Foug. cv. 'Red plume' (dark red) and foliages of Asparagus plumosus Baker. Identical shape, size and colored samples were subjected to dehydration of 3, 5 and 7 days; 2,4,6,7 and 9 days; and 1,2,3 and 4 days for chrysanthemum, asparagus and Gaillardia sp. respectively in silica gel under ambient and microwave-oven condition and glycerin: water @ 1:1, 2:1, 3:1 and 1:1, 1:2, 1:3 for flowers and foliage were utilized as pulsing and 5, 10, 20, 30 and 40mins of absorption followed by alike mode of drying. 68.1, 79.21 and 58.17 percent moisture loss by 60, 120 and 180 seconds treatment under silica gel embedded microwave drying condition were utmost. Glycerin: water@ 2:1 and 1:2 both as pulsing and 5mins absorption could retain all physicochemical properties of two annual flowers and foliage after 1, 2 and 3mins of microwave drying. Treated materials by eosin yellow, red and bromocresol green dye used @ 2ml per 100 ml of standardized glycerin-water showcased competent outcomes irrespective of all samples.

Keywords: Dehydration, dye, embedded, microwave oven, pulsing, silica

Blooms are a ray of beauty out-values all the utilities of the planet. Each flower being a soul, opening out to nature, is not only used for worshipping but also has become an integral part of social, cultural and religious activities. Since these are highly perishable and delicate as well, the life of cut flowers has become limited. The high perishable nature makes these enough vulnerable to large post harvest losses which varied between 28-35 percent (Ranjan and Misra, 2002). Apart from genetic, inherent and biotic factors certain physiological parameters cause stem plugging in cut flowers ultimately impair quality of them while rates of respiration and ethylene evolution are quite high in freshly harvested flowers. So all these pre-harvest, post-harvest and harvest factors make difficult to maintain the beauty and charm of fresh blooms for longer period (Sheela and Chowdhuri, 2008).

Immeasurable resources and diverse agro-climatic zone of India proffers an unique opening for flourishing this dried ornamental sector. The crave of blossoms can be summoned by perfectly dried, preserved and processed flowers and foliages which include novelty, longevity, aesthetics, flexibility and year round availability (Safeena *et al*., 2006). Dhatt *et al*. (2007) explained the prospective of dried rose buds under north Indian climatic conditions. The faded beauty of fresh blossoms often experienced for climatic fluctuations. In contrast the charm of dried ornamental plant parts can be maintained for yearlong with lesser cost, if protected from the damage of high humidity as in dried flowers the microbial activities in the aging process come to stand still (Desh and Gupta, 2006). India exporting dried commodities since last two decades and today India ranks 1st concern this. It constitutes 60 percent of total floriculture exports from India and at present 10,000 ton of dried products are exported to USA, UK, Japan, Israel, Hong Kong, Singapore and other European countries from India (Perinban *et al*., 2014). Indian exporters are riding the crest of a world-wide market demand for floral waste which is estimated at around Rs 500 crore (Muthukumaran, 2012). In the world trade of floriculture, export of desiccated plant products from India have registered an impressive growth from Rs. 224.1 crore in 2006-07 to 363.3 crore in 2012-13 (Fig:1). The science that involves behind dehydration is reduction of moisture content to a point at which bio-chemical changes are minimized there by maintain cell structure, pigment level and flower shape (Singh *et al*., 2006).

Among various techniques of drying suggested by different scientists, most recommended method is the 'embedding method' sustains normal shape of materials (Gill *et al*., 2003). The most commonly used desiccants are silica gel, sand, borax *etc*. For value addition in dry flowers glycerol and dyes can really enhance value of them either by preserving its normal color or by creating a 'novelty' of color for aesthetic beautification. Keeping this in view the present investigation was undertaken with two ornamental annual flower species and one foliage species to retain their physicochemical properties at post-drying stage through silica gel embedded microwave drying and using glycerol along with coloring agents.

MATERIALS AND METHODS

The investigations were orchestrated employing two ornamental annual flower species namely *Chrysanthemum morifolium* Ramat. (Yellow) and *Gaillardia pulchella* Foug. cv. 'Red plume' (dark red) and foliage of *Asparagus plumosus* Baker. They had

Email: moumitamalakar7@gmail.com

gathered randomly in fresh conditions during morning hours from the retail flower market of Mallickghut, Kolkata during December, 2014 to January, 2015. Immediately after the collection, they were placed under a cool place in the laboratory of Department of Horticulture, Institute of Agricultural Science, University of Calcutta. Only flowers and foliage of monotonous shape, size and color having 5 cm long pedicel and petiole were chosen. To reach our objective of preserving the natural hues or creating novelty of color with dried materials, experiments were conducted in 3 parts *viz*. in Experiment I, the effect of duration of drying on materials embedded in silica gel under ambient condition for 3, 5, 7, and 9 days in Chrysanthemum, 2, 4, 6, 7 and 9 days in Asparagus and 1, 2, 3 and 4 days in Gaillardia sp. and microwave oven condition also for 30, 60, 90 seconds, 60, 120, 180, 210 seconds and 30,60,90,120 seconds in Chrysanthemum, Asparagus and Gaillardia sp. respectively were studied while in Experiment II, fresh materials were pulsed for 1 min and treated by 5, 10, 20, 30 and 40mins of absorption using glycerin: water solution @ 1:1, 2:1, 3:1 for flowers and 1:1, 1:2, 1:3 for foliage followed by silica gel embedded microwave drying to find the impact of glycerin on dehydration and lastly (Experiment III), to perceive the influence of dye on color retention, Eosin yellow and red dyes were employed for 2 flowers whereas for Asparagus Bromocresol green were utilized @ 2ml per 100ml of standardized glycerin-water solution followed by endorsed means and duration of drying. Physiochemical properties like size, weight, moisture loss, total sugar and pigment content of fresh and desiccated samples were documented while the overall acceptability of resultant materials depending on color, shape and texture after 10 days of drying were also evaluated. Based on the cumulative scores ranks were given and best treatment in each condition was worked out. In the laboratory the temperature of maximum 17.3-24.8^{0}C, relative humidity of 42-65 percent and light intensity of 40-45 lux were maintained during the period of study.. The experiments were conducted in CRD with factorial concept (Panse and Sukhatme, 1985) where each flower was replicated four times and foliage for three times. The data were subjected to ANOVA using SPSS 10.0 statistical package. The treatment means were compared by Duncan's New Multiple Range Test (DNMRT) at 5 percent probability level.

RESULTS AND DISCUSSION

In Experiment I, every material were desiccated by silica gel embedded method under ambient and microwave oven condition duo for aforesaid period to ascertain the apt mode and duration. So, the consequences of our endeavor were that *Chrysanthemum* sp., *Asparagus* sp. and *Gaillardia* sp. respectively lost 69.3, 58.96, 78.45, 82.45 percent and 68.1, 58.17, 79.21 percent moisture owing to 7, 6 and both 2 and 3 days and 60, 180 and 120 seconds durational treatment under ambient and microwave oven drying condition respectively (Table 1). It is evident by scoring percentage in table 1 that embedding in silica gel followed by microwave drying could rendered earliest drying along with good color, shape and texture retention as compare to room drying irrespective of samples. Dilta *et al*. (2011) reported that increased rate of moisture loss due to more conduction of heat to flower tissues and water evaporation from the surface might have caused rapid drying of flowers at higher temperature. Further the efficacy of silica gel composed of vase network of interconnected microscopic pores which attract and hold moisture by phenomenon known as physical adsorption and capillary condensation for its strong hygroscopic nature was corroborated also (Nirmala *et al*., 2008, Wilson *et al*., 2015).

In succeeding part of investigation, fruitful proportion and optimum duration of absorption of diverged glycerin-water (v/v) concentrations were standardized since glycerin possesses hygroscopic attributes. In this section both mode of dehydration were considered although superior outcomes obtained by microwave drying. Among three concentrations of glycerin-water solution, 2:1 and 1:2 found to be highly efficient for two annual ornamental flower species and a foliage species. Batra, 2016 and Tomar *et al*., 2012 set forth that retention of natural beauty of fresh foliages or flowers can be accomplished by injecting humicants of polyol group *viz*. glycerin, ethylene glycol *etc*. Regarding *Chrysanthemum morifolium*, both pulsing and 5 mins absorption followed by embedded silica gel-microwave drying for 60 sec caused not only utmost moisture loss of 68.97 and 67.74 per cent but also preserved anthocyanin pigment of 24.4 and 24.32mg/100g juxtapose to initial pigment level of 0.24mg/100g along with reduced sugar level (Table 2). The influence of silica gel embedded room temperature drying for 7 days were almost *at par* but size reduction percentage was noticeably higher while disappointed outcome noted under identical means of drying for 3 days in *Gaillardia pulchella* as evinced by table 2. It exhibited unbeatable results concerning moisture loss percent (74.71 and 73.96%) and other post-drying quality parameters under silica gel embedded microwave drying for 120 sec. Microwave drying proved best in respect of drying duration, qualitative and quantitative characteristics since it liberates moisture by agitating water molecules in organic substances with aid of electronically produced microwaves than room drying (Dutta, 2007; Biswas and Dhua, 2010). Thirty four centimeter long fresh stems of

Table 1: Effect of duration of silica gel embedded drying under ambient and microwave oven condition on utilized samples.

Treatment	Condition	Duration (days/sec)	ML%	SC%
		Chrysanthemum morifolium		
Control	**RT**	3	66.2c	55.63
	5	68.6b	90.23	
	7	69.3b	85.69	
	9	71.2a	60.23	
M	30	65.3b	59.63	
	60	68.1ab	95.26	
	90	69.3a	84.12	
		Gaillardia pulchella		
Control	**RT**	1	70.10b	69.21
	2	78.45ab	88.69	
	3	82.45a	87.25	
	4	84.97a	72.30	
M	30	67.76c	72.00	
	60	72.61b	79.00	
	90	75.09ab	89.00	
	120	79.21a	91.20	
		Asparagus plumosus		
Control	**RT**	2	52.01c	59.21
	4	55.27c	65.41	
	6	58.96bc	80.13	
	7	60.13b	74.21	
	9	64.16a	54.13	
M	60	50.34c	52.13	
	120	55.43bc	70.13	
	180	58.17b	82.13	
	210	62.41a	59.47	

Note: Similar words are not significant i.e. they are statistically at par.
RT- Room temperature, M- Microwave oven, ML- Moisture loss, SC- Scoring

annual statice (*Limonium sinuatum* Mill.) could be conserved also by soaking in 2:1 or 1:2 glycerol water solutions for 2days followed by microwave treatment for 1 min (Radha Rani, 2015; Safeena and Patil, 2014). Asparagus plumosus treated in 1:2 glycerin-water solutions followed by dehydration in microwave for 180 seconds furnished unsurpassable physiochemical properties (Table2) as it replenished the natural moisture of the leaf with a substance that maintains leaf form, texture, sugar level and hue (Dutta and Roy, 2011). It was perceived that increase in glycerin uptake is positively correlated with the accelerated concentration of it. Similar findings were also found by Jain *et al*., 2016 and Bhalla *et al*., 2006. Here, pigment level irrespective of samples was facilitated in all treatments but it was associated with the raise of absorption time. Our consequences are in full accordance with the outcomes of Meman and Barad, 2009. They observed least flower diameter and highest pigment content when flowers were embedded in silica gel for 36 hours duration at 600C.

In last part of experiment (III) the potency of eosin yellow and red dyes for two flowers and bromocresol green dye for foliage were evaluated. The data presented in table 3 clearly states that pulsing and 5 min absorption of corroborated glycerin-water solution here also yielded better consequences. Glycerin-dye treated samples were dehydrated under ambient and microwave state duo but superior outcome regarding moisture loss (%) showcased by later one irrespective entire materials involved. Size reduction (%) was more or less at par for both conditions of desiccation according to the statistical analysis for all species. Maximum anthocyanin content of 25.89 mg $100g^{-1}$ was found in *Chrysanthemum morifolium* after

Table 2: Effect of divergent glycerin: water solution under ambient temperature and microwave oven drying on utilized samples.

Chrysanthemum morifolium																			
Ambient temperature (7 days)										Microwave oven condition (60 seconds)									
G:W	Ab.T (min)	ML (%)	SR (%)	TS (%)	AP (mg $100g^{-1}$)	SC (%)	Remarks Color	Remarks Shape	Remarks Texture	G:W	Ab.T (min)	ML (%)	SR (%)	TS (%)	AP (mg $100g^{-1}$)	SC (%)	Remarks Color	Remarks Shape	Remarks Texture
1:1	T_1	68.43a	2.29a	48.13d	24.2a	94.89a	Dark	Intact	Smooth	1:1	T1	69.21a	2.27a	56.32a	24.25a	94.71a	Dark	Intact	Smooth
	T_2	67.86b	2.26b	48.98cd	24.18a	94.62a	Slightly dark	Intact	Smooth		T2	68.59b	2.22a	57.02d	24.13a	91.78b	Dark	Intact	Smooth
	T_3	66.97b	2.21b	49.33bcd	24.14a	89.89b	Slightly dark	Intact	Smooth		T3	67.39c	2.19a	57.89cd	24.01a	88.9c	Dark	Intact	Smooth
	T_4	66.08c	2.18b	50.13bc	23.87a	82.36c	Intact	Intact	Smooth		T4	66.41d	2.16ab	58.55c	23.85a	81.9d	Intact	Intact	Smooth
	T_5	65.72cd	2.13b	50.95ab	23.79a	78.59d	Intact	Flattened	Smooth		T5	65.86e	2.11ab	58.95ba	23.82a	73.41e	Intact	Intact	Smooth
	T_6	65.14d	2.09b	51.98a	20.22b	67.85e	Slightly faded	Slightly deformed	Slightly shrinked		T6	64.28f	2.02b	61.62a	23.79a	69.21f	Intact	Intact	Smooth
2:1	T_1	68.15a	2.24a	48.38e	24.3a	95.2a	Dark	Intact	Smooth	2:1	T1	68.97a	2.21a	56.12d	24.4a	95.31a	Dark	Intact	Smooth
	T_2	67.76ab	2.21b	49.17de	24.23ab	94.96a	Dark	Intact	Smooth		T2	67.74b	2.2a	56.98cd	24.32a	94.89b	Dark	Intact	Smooth
	T_3	67.11bc	2.18b	49.98cd	23.89ab	89.55b	Slightly dark	Intact	Smooth		T3	66.78c	2.18ab	57.46c	24.26a	93.56c	Dark	Intact	Smooth
	T_4	66.92c	2.13b	50.12c	23.85ab	82.97c	Slightly dark	Intact	Smooth		T4	66.02d	2.15ab	57.99bc	24.03a	83.02d	Dark	Intact	Smooth
	T_5	66.08d	2.09b	21.01b	23.84ab	79.6d	Intact	Intact	Smooth		T5	65.78d	2.11ab	58.79b	23.89ab	78.26e	Intact	Intact	Smooth
	T_6	65.13e	2.05b	53.23a	23.56b	69.88e	Intact	Flattened	Slightly shrinked		T6	65.49e	2.08b	59.96a	23.85ab	68.99f	Intact	Intact	Smooth
3:1	T_1	68.41a	2.26a	48.48e	24.00a	90.13a	Dark	Intact	Smooth	3:1	T1	69.05a	2.24a	56.41a	24.13a	92.31a	Dark	Intact	Smooth
	T_2	67.85ab	2.21ab	49.13d	23.90a	89.95a	Slightly dark	Intact	Smooth		T2	68.49b	2.21ab	57.89b	24.02a	90.21b	Dark	Intact	Smooth
	T_3	67.04d	2.17ab	50.02c	23.85a	89.46a	Intact	Intact	Smooth		T3	67.28c	2.19abc	58.12ab	23.85ab	88.74	Dark	Intact	Smooth
	T_4	66.82b	2.12ab	50.98b	23.82a	72.55a	Intact	Flattened	Slightly shrinked		T4	67.16c	2.18abc	58.97bc	23.23b	81.13	Intact	Intact	Smooth
	T_5	65.13c	2.08ab	51.17b	23.80a	72.02a	Intact	Flattened	Slightly shrinked		T5	66.9c	2.14cd	59.87d	21.13c	74.74e	Intact	Intact	Smooth
	T_6	64.79c	2.02b	53.77a	23.74a	68.12b	Slightly faded	Slightly deformed	Shrinked		T6	65.57d	2.11d	61.23a	19.56d	68.58f	Slightly faded	Flattened	Slightly shrinked

Contd.

Table 2 Contd.

Gaillardia pulchella

G:W	Ab.T (min)	ML (%)	SR (%)	TS (%)	AP (mg 100g^{-1})	SC (%)	Color	Shape	Texture	G:W	Ab.T (min)	ML (%)	SR (%)	TS (%)	AP (mg 100g^{-1})	SC (%)	Color	Shape	Texture
	Ambient temperature (3 days)						Remarks				Microwave oven condition (120 seconds)						Remarks		
1:1	T_1	56.89a	1.5a	3.21a	40.23a	80.71a	Faded	Deformed	Shrinked	1:1	T1	74.47a	1.8a	5.78a	42.70ab	90.04a	Intact	Intact	Smooth
	T_2	55.23a	1.42a	3.29a	40.35a	78.78b	Faded	Deformed	Shrinked		T2	74.08ab	1.89a	5.82a	42.72ab	87.42b	Intact	Intact	Smooth
	T_3	55.14ab	1.11a	3.38a	40.38a	78.90b	Faded	Deformed	Shrinked		T3	73.91b	1.92a	5.89a	42.79ab	83.17c	Slightly faded	Intact	Smooth
	T_4	53.01b	1.32a	3.56a	40.58a	61.9c	Faded	Deformed	Shrinked		T4	73.14c	1.97a	5.91a	42.85ab	79.97d	Slightly faded	Flattened	Smooth
	T_5	50.89c	1.25a	3.42a	40.79a	53.41d	Faded	Deformed	Shrinked		T5	70.44c	2.01a	5.94a	42.91a	73.41e	Slightly faded	Flattened	Shrinked
	T_6	50.23c	1.35a	3.58a	40.81a	49.21e	Faded	Deformed	Shrinked		T6	68.92d	2.03a	5.98a	42.96a	67.41f	Dark brown	Deformed	Shrinked
2:1	T_1	57.21a	1.41a	3.33a	40.56a	85.20a	Slightly faded	Deformed	Shrinked	2:1	T1	74.71a	1.81c	5.72a	42.72a	91.16a	Intact	Intact	Smooth
	T_2	56.92ab	1.40a	3.45a	40.62a	74.96b	Slightly faded	Deformed	Shrinked		T2	73.96b	1.83c	5.79a	42.75a	89.17b	Intact	Intact	Smooth
	T_3	54.02b	1.35a	3.49a	40.69a	69.55c	Slightly faded	Slightly deformed	Shrinked		T3	73.68b	1.89bc	5.82a	42.81a	85.47c	Intact	Intact	Smooth
	T_4	54.69b	1.33a	3.56a	40.78a	62.97cd	Faded	Flattened	Shrinked		T4	73.08c	1.92ab	5.88a	42.88a	81.03d	Almost intact	Intact	Smooth
	T_5	50.36c	1.23a	3.59a	40.90a	59.60d	Faded	Flattened	Shrinked		T5	71.94d	1.96ab	5.93a	42.92a	76.43e	Slightly faded	Flattened	Smooth
	T_6	50.01cd	1.26a	3.59a	40.90a	59.88d	Faded	Flattened	Shrinked		T6	69.24e	1.99a	5.98a	42.99a	70.01f	Dark brown	Flattened	Smooth
3:1	T_1	57.89a	1.59a	3.49a	40.13a	81.88a	Faded	Deformed	Shrinked	3:1	T1	74.53a	1.83c	5.81a	42.71a	90.03a	Intact	Intact	Smooth
	T_2	57.13a	1.50a	3.50a	40.98a	77.07b	Faded	Deformed	Shrinked		T2	73.52b	1.89bc	5.89ab	42.76a	86.52b	Intact	Intact	Smooth
	T_3	55.69b	1.44a	3.50a	40.33a	68.44c	Faded	Deformed	Shrinked		T3	73.61b	1.92bc	5.92ab	42.82a	82.19c	Slightly faded	Intact	Smooth
	T_4	55.99b	1.46a	3.56a	40.13a	62.19d	Faded	Flattened	Shrinked		T4	72.72b	1.97abc	5.97ab	42.89a	79.67d	Slightly faded	Intact	Smooth
	T_5	52.36c	1.41a	3.61a	40.95a	58.28e	Faded	Flattened	Shrinked		T5	70.37c	2.02ab	6.04ab	42.93a	72.71e	Slightly dark brown	Flattened	Shrinked
	T_6	51.08d	1.32a	3.60a	40.98a	49.17f	Faded	Flattened	Shrinked		T6	66.28e	2.08a	6.11b	42.97a	66.23f	Dark brown to black	Deformed	Much shrinked

Contd.

Table 2 Contd.

Asparagus plumosus

Ambient temperature (6 days)									Microwave oven condition (180 seconds)								
G:W	Ab.T (min)	ML (%)	TS (%)	CP (mg g-1)	SC (%)	Remarks: Color	Shape	Texture	G:W	Ab.T (min)	ML (%)	TS (%)	CP (mg g-1)	SC (%)	Remarks: Color	Shape	Texture
1:1	T_1	60.01a	4.2d	1.08abc	65.13cd	Faded	Slightly deformed	Less fall	1:1	T1	61.96a	401f	1.04ab	65.87d	Faded	Slightly deformed	Extreme fall
	T_2	59.13b	4.5cd	1.02bc	64.98cd	Faded	Slightly deformed	Less fall		T2	60.38b	4.8ef	1.02ab	65.09de	Faded	Slightly deformed	Extreme fall
	T_3	58.92b	4.9cd	0.98c	63.14de	Faded	Deformed	Extreme fall		T3	58.29c	5.1def	0.85bc	64.47ef	Slightly brownish	Slightly deformed	Extreme fall
	T_4	58.16c	5.2c	0.55d	61.81ef	Brownish	Deformed	Extreme fall		T4	57.84cd	5.7cde	0.56cd	64.13f	Brownish	Deformed	Extreme fall
	T_5	57.73d	5.2c	0.56d	60.07f	Brownish	Deformed	Extreme fall		T5	56.95de	6.1cd	0.47d	63.87f	Brownish	Deformed	Extreme fall
	T_6	56.88e	6.5b	1.19abc	66.13c	Slightly dark	Slightly deformed	Less fall than earlier		T6	56.01ef	6.8bc	1.19a	73.42c	Intact	Slightly deformed	Less fall than earlier
1:2	T_1	60.92a	4.1f	1.07a	66.37d	Faded	Slightly deformed	Less fall	1:2	T1	62.32a	4.2c	1.08ab	67.88c	Faded	Slightly deformed	Extreme fall
	T_2	59.97b	4.6ef	1.09abc	63.13e	Faded	Slightly deformed	Less fall		T2	60.07b	4.7c	1.02ab	67.07c	Faded	Slightly deformed	Extreme fall
	T_3	59.01c	5.1e	0.54d	60.13f	Brownish	Deformed	More fall than earlier		T3	59.82b	5.2c	0.98ab	68.04c	Slightly brownish	Deformed	Extreme fall than earlier
	T_4	58.17d	5.8d	0.89c	66.73d	Slightly dark	Deformed brownish	More fall		T4	58.72e	5.7bc	0.79ab	68.19c	Slightly brownish	Deformed	Less fall than earlier
	T_5	57.98d	6.2cd	0.94bc	69.71c	Slightly dark	Less deformed	More fall than earlier		T5	58.13cd	6.2bc	0.63d	68.28c	Slightly brownish	Deformed	Less fall than earlier
	T_6	57.01e	6.7bc	1.18abc	72.37b	Intact	Intact	No fall		T6	57.57de	6.9ab	1.23a	89.17b	Intact	Slightly deformed	Less fall than earlier
1:3	T_1	60.18a	4.3e	1.06ab	66.13b	Faded	Slightly deformed	Less fall	1:3	T1	61.21a	4.3e	1.05ab	68.14c	Faded	Slightly deformed	Extreme fall than earlier
	T_2	59.72ab	4.6e	1.02ab	62.89c	Faded	Slightly deformed	More fall than earlier		T2	60.27a	4.8e	0.98ab	67.98c	Faded	Slightly deformed	Extreme fall than earlier
	T_3	58.78ab	5.2de	0.97ab	62.04d	Faded	Slightly deformed	More fall than earlier		T3	59.98b	5.3d	0.85b	65.13d	Faded	Deformed	Extreme fall
	T_4	57.17abc	5.7cde	0.55ce	60.89e	Brownish	Deformed	Extreme fall		T4	59.01c	5.9cd	0.52c	63.17e	Brownish	Deformed	Extreme fall
	T_5	56.97abcd	6.1bcd	0.59ce	60.74e	Brownish	Deformed	Extreme fall		T5	58.87d	6.1cb	0.41c	62.02e	Brownish	Deformed	Extreme fall
	T_6	55.76abc	6.7bc	0.85b	63.13c	Slightly brownish	Deformed	Extreme fall		T6	57.75d	6.7bc	1.17a	80.43b	Intact	Slightly deformed	Extreme fall

Table 3: Effect of dyes mixed with standardized glycerin: water solution under ambient temperature and microwave oven drying on utilized samples.

Condition	Ab.T (min)	ML (%)	SR (%)	TS (%)	AP (mg 100g^{-1})	SC (%)	Remarks Color	Shape	Texture
Chrysanthemum morifolium									
Glycerin: Water (2:1)									
RT	T_1	68.56a	2.26a	48.85d	24.56a	93.13a	Dark	Intact	Smooth
	T_2	67.89ab	2.23a	49.52cd	24.12a	90.89b	Dark	Intact	Smooth
	T_3	67.12bc	2.18ab	50.13c	23.89a	89.87c	Dark	Intact	Smooth
	T_4	66.78d	2.13ab	52.36b	23.02b	89.17d	Dark	Intact	Smooth
	T_5	66.05dc	2.09ab	54.65ab	21.23c	80.17e	Intact	Intact	Smooth
	T_6	65.06e	2.02b	55.89a	20.13d	70.11f	Intact	Intact	Smooth
M	T_1	69.43a	2.28a	55.74a	25.89a	95.23a	Dark	Intact	Smooth
	T_2	68.97a	2.25ab	56.12b	24.89b	92.71b	Dark	Intact	Smooth
	T_3	68.08b	2.20abc	56.98c	24.03c	90.02c	Dark	Intact	Smooth
	T_4	67.07b	2.17abc	57.23cd	23.59c	89.05c	Dark	Intact	Smooth
	T_5	67.87c	2.13bc	58.89cd	22.89d	83.17d	Intact	Intact	Smooth
	T_6	66.11d	2.07c	60.25d	20.98e	72.70d	Intact	Intact	Smooth
Gaillardia pulchella									
Glycerin: Water (2:1)									
RT	T_1	72.14a	1.71a	4.25c	40.59a	81.70a	Intact	Flattened	Smooth
	T_2	72.01a	1.69a	4.50c	40.65a	79.68b	Intact	Flattened	Smooth
	T_3	70.56ab	1.56ab	5.23b	40.85a	79.90b	Intact	Flattened	Shrinked
	T_4	69.89b	1.49ab	5.89b	41.58ab	62.90c	Intact	Flattened	Shrinked
	T_5	69.47b	1.38b	5.99b	41.79ab	55.41d	Intact	Flattened	Shrinked
	T_6	65.23c	1.21b	6.42a	41.81ab	49.21e	Intact	Flattened	Shrinked
M	T_1	74.17a	1.82c	5.82a	43.08a	90.14a	Intact	Intact	Smooth
	T_2	73.01b	1.86abc	5.88a	43.13a	88.97ab	Intact	Intact	Smooth
	T_3	72.78c	1.89abc	5.94a	43.21a	85.69bc	Intact	Intact	Smooth
	T_4	72.13d	1.92ab	5.98a	43.32a	80.12c	More or less intact	Flattened	Smooth
	T_5	70.14e	1.95ab	6.02a	43.47a	72.41cd	More or less intact	Flattened	Shrinked
	T_6	68.13f	1.97a	6.08a	43.58a	68.13d	Dark brown turning black	Flattened	Shrinked

Asparagus plumosus

Glycerin: Water (1:2)

Condition	Ab.T (min)	ML (%)	TS (%)	AP (mg 100g^{-1})	SC (%)	Remarks Color	Shape	Texture
RT	T_1	61.35a	4.2e	1.02b	65.34e	Faded	Almost intact	Less fall
	T_2	60.59b	4.6de	1.03b	64.98ef	Faded	Almost intact	Less fall
	T_3	60.03bc	5.2cd	0.86b	64.04f	Slightly brown	Slightly deformed	More fall than earlier
	T_4	59.74cd	5.7c	0.98b	66.13e	Slightly less brown	Deformed	More fall than earlier
	T_5	59.14de	6.2c	1.21a	72.37d	Intact	Almost intact	Less fall than earlier
	T_6	58.67e	6.9d	1.24a	80.31c	Dark	Intact	No fall
M	T_1	62.04a	4.3h	1.03b	66.34d	Faded	Almost intact	Less fall
	T_2	60.97b	4.7g	1.01b	64.17f	Faded	Almost intact	Less fall
	T_3	59.59c	5.3f	0.87c	63.14g	Brownish	Deformed	More fall than earlier
	T_4	58.81cd	5.9e	0.97b	66.78e	Slightly less brown	Slightly deformed	Less fall than earlier
	T_5	57.97de	6.7d	1.23a	71.84d	Intact	Intact	No fall
	T_6	57.13ef	7.1c	1.25a	80.39c	Dark	Intact	No fall

Note: Similar words are not significant (i.e they are statistically at par) RT- Room temperature, M- Microwave oven, Ab.T- Absorption time, Ml- Moisture loss, TS- Total sugar, AP- Anthocyanin pigment, CP- Chlorophyll pigment, SC- Scoring, T_1- Pulsing, T_2- 5min, T_3- 10min, T_4- 20min, T_5- 30min, T_6- 40min.

the pulsing treatment but in case of *Asparagus plumosus* and *Gaillardia pulchella* pigment level was found to be improved with the enhancement of absorption time *i.e*., highest 1.25 mg/g chlorophyll and 43.58 mg 100 g^{-1} anthocyanin were obtained after 40 min of imbibitions as compare to 1.03 mg/g chlorophyll and 43.08 mg 100 g^{-1} anthocyanin preserved after 5 min absorption in asparagus and *Gaillardia* sp. both. Glycerol's concentration, ionic strength, pH, vapour pressure deficit *etc*. persuade its uptake (Joyce and Dubois, 1992). Acceleration of sugar content was found also to be linked with the augmentation of imbibitions period. Lynn, 2008; Willson *et al*., 2015; Jain *et al*., 2016 and Batra, 2015 reported that compatible coloring agents enacted vital role to preserve natural color of dehydrated materials while glycerin added a soft feel and suppleness to them. Here, the overall longevity of all microwave oven dried samples were satisfactory under both open and confined situation except Gaillardia where closed condition commit better longevity.

Desiccated flowers or foliages being cheap and everlasting, are becoming first choice for adventurous flower lovers across the globe somewhat on the expense of fresh flowers. But in India research is very finite and published information on dry flowers are almost nil. Among various way of dehydration silica gel embedding method under microwave drying for *Chrysanthemum morifolium*, *Gaillardia pulchella* cv. 'Red plume' and Asparagus plumosus for 1, 2 and 3mins are most apposite. On the other hand, dyes @ 2 ml per 100 ml of standardized glycerin: water solution *viz*. 2:1 and 1:2 for flowers and foliage respectively as pulsing and 5mins absorption could be desiccated aforementioned species without hampering their post-drying quality parameters. Dry flowers hold an eminent position in the modern floriculture trade, providing an aura of beauty and naturalistic effect for flower cravers owing to its long lasting quality (Dutta, 2004). Thus, dry flowers have become a momentous substitute of fresh blooms, if protected from damage due to high humidity after drying.

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REFERENCES

Batra, A. 2016. Dissemination of dry flower technology for societal good. *Int. J. Curr. Res. Biosci. Pl. Biol*., **3 :** 97-101.

Batra, A. 2015. To study the behaviour of colour change in some dehydrated ornamental flowers. *Int. J. Latest Res. Sci. Tech*., **4**: 141-44.

Bhalla, R., Dhiman, S.R. and Thakur, K.S. 2006. Standardization of drying techniques of chrysanthemum (*Dandranthema grandiflorum* Tzvelev.). *J. Orna. Hort*., **9**: 159- 63.

Biswas, C. and Dhua, R.S. 2010. Microwave oven drying of cut carnation. *J. Orna. Hort*., **13**: 45-49.

Desh, R. and Gupta, P.K. 2006. Standardizing dehydration technology for ornamental plants parts of shrubs from mid-hills of Himachal Pradesh. *J. Orn. Hort.*, **8**: 53-55.

Dhatt, K.K., Singh, K. and Kumar, R. 2007. Studies on methods of dehydration of rose buds. *J. Orn Hort*., **10**: 264-67.

Dilta, B.P., Sharma, B.P., Baweja, H.S. and Kashyap, B. 2011. Flower drying techniques - A review. *Int. J. Farm Sci*., **1**: 1-16.

Dutta, S.K. 2004. Dehydration of flowers: A new diversified product for floriculture industry and emerging trends in ornamental horticulture. *Indian Soc. Orn Hort*., **6**:157–61.

Dutta, S. K. 2007. *Underutilized and Underexploited Horticultural Crops*. New India Publishing Agency, New Delhi, pp.159-70.

Dutta, S. K. and Roy, S. 2011. Employment generation using dehydration technology for drying flowers and foliage and floral craft. *Sci. Cult.*, **77**: 58–61.

Gill, S.S., Bakshi, R. and Arora, S. 2003. Evaluation of various methods of drying flowers and foliage. *J. Orn Hort*., **5**: 56-57.

Jain, R., Janakiram, T. and Kumawat, G.L. 2016. Drying techniques in ornamental plants. In. *Commercial Horticulture* (Eds.) New India Publishing Agency, New Delhi, pp. 501-12.

Joyce, D.C. and Dubious, P. 1992. Preservation of fresh cut ornamental plant material with glycerol. *Postharvest Bio. Tech*., **2** : 145-53.

Lynn, B. 2008. The flower farmer : *An Organic Growers Guide to Raise and Sell Cut Flowers*. Green Publication, Chelsa, pp. 284.

Meman, M. and Barad, A.V. 2009. Study on dry leaf production of asparagus. *J. Hort. Forestry*, **1**: 43-47.

Muthukumaran, K. 2012. *Indian Floriculture Industry: Opportunities and Challenges*. CAB Calling, College of Agricultural Banking. pp. 49-53.

Nirmala, A., Chandrashekhar, A., Padma, A. and Rajkumar, M. 2008. Standardization of drying techniques of carnations (*Dianthus caryophyllus*). *J. Orn Hort*., **11**: 168-72.

Panse, V.G. and Sukhatme, P.V. 1985. *Statistical Methods for Agricultural Workers*. ICAR, New Delhi, pp. 200-45.

Perinban, S., Majumder, J., Singh, B., Rai, P. and Kumar, R. 2014. Dried flowers: A new paradigm in floriculture. *Krishisewa*. 19 March, 2014, India, pp. 1. Retrieved from: http://www. krishisewa. com/articles/pht/394-dried-flowers.html.

Radha Rani, P. and Reddy, M.V. 2015. Dehydration techniques for flowers. *Intl. J. Appl. Res.*, **1**: 306-11.

Ranjan, J.K. and Misra, S. 2002. Dried flowers: A way to enjoy their beauty for a long period. *Indian Hort.*, **12**: 32-33.

Safeena, S.A., Patil, V.S. and Naik, B.H. 2006. Standardization of stage of harvest for better quality of dry flowers of rose. *J Orn. Hort.*, **9**: 224-26.

Safeena, S.A. and Patil, V.S 2014. Studies on the effect of microwave oven drying on flower quality of dried Dutch rose flowers. *Nat. Acad. Sci. Lett.*, **37**: 19-24.

Sheela, V.I. and Chowdhuri, M.L. 2008. Dry flower: A profitable floriculture industry. In. *Flower for Trade* (Eds.) New Delhi Publishing Agency, India, pp. 65-75.

Singh, A., Dhaduk, B.K. and Shah, R.R. 2006. Effect of different temperatures and embedding media on flower dehydration of Zinnia (*Zinnia linearis* Benth.). *Indian J. Hort.*, **61**: 249-52.

Tomar, K. S., Kumar, S. and Shakywar, R.C. 2012. Flower Dehydration: A Profitable Business for Rural People. *Krishisewa*. 29 Octobar, 2012, India. Retrieved from: http://www. krishisewa. com/articles/pht/125-flower-dehydration.html.

Willson, D., Attri, B.L. and Sharma, S.K. 2015. Evaluation of different methods of during of Chrysanthemum flowers. *Prog. Hort.*, **47** : 167-69.

Roy, A., Panwar, D. V. S. and Sarma R. N. 1995. Genetic variability and causal relationship in rice. *Madras Agric. J.* **82**: 251-55.

S. Kour and U.K. Pradhan 2016. Correlation, path coefficient analysis and construction of indices for yield and yield components selection in forage sorghum [*Sorghum bicolor* (L) Moench]. *J Crop Weed*, **12**(2) : 01-09

Saravanan, R. and Senthil, N. 1997. Genotypic and phenotypic variability, heritability and genetic advance in some important traits in rice. *Madras Agric. J.* **84**: 276-77.

Tammam, A.M., El-Ashmoony, M.S.F., El-Sherbeny, A.A. and Amin, I.A. 2004. Breeding for drought tolerance and the association of grain yield and other traits of bread wheat. *Egyptian J Agril Res*. **82**(3): 1227-41.

Venkataramana, P and Shailaja, H. 1999. Genetic variability on some important traits in two F2segregants of rice (*Oryza sativa* L.) under non-submergence condition. *Crop Res.* Hisar. **18**(1): 53-56

Wu MingGuo., Lin, J. R. and Zhang, G. H. 2004. Genetic analysis of leaf relative water content in paddy-upland hybrid rice. *Chinese J Rice Sci*. **18**(6): **570-72.**