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Standardization of stage of harvest and storage method for dried Rose Var. Tajmahal

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Abstract
The present investigation was conducted to assess the influence stage of harvest and storage method on storage quality of the dried rose. The flowers were harvested at different stage *viz.*, just open stage, half open stage and petal intact stage and these flowers were subjected to hot air drying at 50ºC for 42 hours by embedding them in silica gel and stored in transparent and opaque acrylic box. The maximum sensory score for colour (8.36, 8.30, 8.23 and 8.10), shape (8.27, 8.15, 8.02 and 7.98), texture (8.28, 8.19, 8.10 and 7.94) and over all acceptability (8.22, 8.05, 8.03 and 7.89) for dried flower during storage period (0, 30, 60 and 90 DAS) was recorded when half open stage flowers were dried and kept in opaque acrylic box while, it was found to be minimum colour (7.58, 7.39, 7.29 and 7.08), shape (7.50, 7.42, 7.36 and 7.28), texture (7.44, 7.40, 7.13 and 7.08) and over all acceptability (7.35, 7.24, 7.19 and 6.98) when just open stage flower which are kept in transparent acrylic box. The minimum dry weight (1.33, 1.36, 1.38, 1.38 g respectively) and moisture gain per cent (2.13, 3.27 and 3.27% respectively) during storage period (Initial, 30, 60 and 90 DAS) and (30, 60 and 90 DAS) was observed when half open stage flower were kept in transparent acrylic box whereas, the just open stage flower which are kept in opaque acrylic box recorded maximum dry weight (1.78, 1.84, 1.87, 1.87 g respectively) and moisture gain per cent (3.20, 4.80 and 4.96%) during storage period respectively.

Keywords: Rose, oven, desiccant and acrylic box

Introduction
Demand for dried flowers is growing day by day in both national and international market because, the consumers start to choose dried flowers as the biodegradable and environmental friendly. The benefits of dried flowers over fresh flowers are that, they can be stored and cherished for years without deterioration of its shape and appearance. Dry flowers can also be utilized in making decorative floral objects for home decoration and commercial use and it is advisable to keep these products throughout the year by shielding them from atmospheric humidity, wind and dirt (Ranjan and Mishra, 2002) [11].

The beauty, purity and quality of fresh flowers can be preserved for a period of few days or even weeks together. However, in case of dried flowers it is possible to maintain the quality and appearance of fresh flowers for fewer months to several years together by applying appropriate drying techniques. The most popular methods of drying of flowers and foliage are press drying, air drying, desiccant (silica gel, borax and sand) drying, hot air oven and microwave oven drying and to avoid the issue regarding petal shrinkage the flowers should be dried in an embedding technique. The materials which are used for embedding of flowers and foliage's should be very fine (0.02- 0.2 mm) in nature for faster drying and to retain its shape in original form (Bhattacharjee and De, 2003) [4].

Moisture content is considered as critical factor that determines the durability and marketability of horticultural products. In general, flowers having less vase life, attractiveness and appearance are greatly influenced by presence or lack of water content in the dried material. In this regard, flowers are dried up to moisture content of 8-11.5 per cent to minimize the biochemical changes, maintain the cell structure, stiffness, quality and durability Whereas, stage of harvest, type of flower and other harvesting factors plays an important role on quality parameters. It is advisable to harvest the flower when they attain full bloom stage and foliage at their peak of growing season. Different drying materials like white sand, sawdust, boric acid, silica gel etc., are used for drying for quick dehydration, electrically operated hot-air or microwave ovens are also used (Acharyya *et al*., 2013) [1].

Rose is one of the most beautiful and oldest flowers and it is universally regarded as the "Queen of flowers". It represents love, adoration and innocence. It belongs to the family Rosaceae and genus *Rosa*, which comprises nearly 120 species and 30,000 cultivars. Thebest time to harvest plant material is late morning, after the dew has dried but before the heat of the afternoon. Excess moisture can cause spotting on plant material and may cause mould to grow during the storage period. Plant stems should be placed into bucket containing water immediately after cutting because fully hydrated plant material will preserve the best after drying process (Smith, 2010) [15].

Dry flowers are fragile and require careful handling. Before using dried materials for making decorative items, it is necessary to protect them from all possible hazards. A wide variety of dried flowers are prepared for good quality products but after some time due to the dust, humidity, molds and insects they may spoil their colour and shape. Therefore dried flower products' display packaging is of prime requirement in the present competitive market. Therefore, dried material should be stored in a dark, dry airtight container. A layer of tissue paper should be placed between flowers to reduce breakage (Bhupender, 2012) [5].

Packaging material should be stable and firm to hold the dry flowers well without any damage during storage. A great variety of materials are used for the packing of perishable commodities. They include wood, bamboo, rigid and foam plastic, solid cardboard and corrugated fiber board. Dehydrated plant parts may be arranged aesthetically and covered with plastic or transparent glass to protect them from atmospheric humidity, wind and dust and the Flower which are stored in cardboard boxes without any lining proved to be better than those stored by inserting in polythene covers with respect to retention of colour on storage. Damage of flowers was more in cardboard boxes than polythene cover (shital, 2017) [14]. Acrylic was given first preference for table mount and potpourri followed by glass, plastic and thermocol. It might be due to transparent characteristic of the material which allows the consumer to see the beauty of the dried flower arrangement inside the container and it is also stronger than glass. The flower which is kept for storage in open condition shows good keeping quality as compared to the dried flowers which was stored in opaque container. It might be due to the direct exposure of dried flowers with the environmental factors (Radharani, 2011) [9].

Shirin (2011) [13] stated that different packaging methods significantly influenced on the overall quality of the exotic flowers on storage. Dried flowers which are stored in air tight plastic containers was proved to be better than those stored by inserting in polythene covers with respect to retention of colour, texture form and appearance on storage.

Floriculture is evolved as a profitable occupation with high return ability than other field and many horticultural crops (Raghava, 2001) [10]. In India, particularly with respect to dry flower production and its export having a great demand in market but, till today it is the most ignored industry. There is an unlimited opportunity in this field but it needs a sincere effort to attain a significant position in the global market. India's export share on floriculture production 2018-19 was 571.57 crores, by exporting 19.72 thousand MT of floriculture products. Dry flowers contribute around 70 per cent revenue of total floriculture export. Export of dried flowers from India is worth of Rs. 252.26 crore. Major exporters of dry flowers are Netherlands (51.20%), Israel (14.20%), Nigeria (5.60%), and India (4.80%) (Amita and Baweja, 2019) [2]. Considering the potential of rose in dry flower industries, the present studies were undertaken to study the effect of stage of harvest and storage method on storage quality of the dried flowers to assess the storage quality.

Materials and Methods

The present investigation was carried out during 2019-2020 in the Department of Floriculture and Landscape Architecture, KRC College of Horticulture, Arabhavi to assess the different stage of harvest and storage method on dried flower quality of rose flowers. The experiment was laid out in CRD design with three replications. The flowers were harvested at just open stage, half open stage and petal intact stage by cutting with sharp secateurs in early morning within 9 am. Immediately after picking, cut ends of the flower stalks are submerged in clean water. Stems of uniform thickness were picked and cut up to uniform length of 5 cm and 5 flowers per replication was imposed for each treatment. The flowers which are harvested at different stages (Just open stage, half bloom stage and Petal intact stage) are placed in trays and subjected to drying in electrically powered hot air oven at 50°C for 42 hours by embedding with silica gel and it should be kept undisturbed for 8 to 12 hours for proper removal of moisture from the flowers. After the completion of drying process and setting time, the containers were gently inclined over to remove the dried flower from embedding material without making any mechanical damage. The dried flowers were lifted up by hand; clean the embedding material which is adsorbed on the flower by inverting them and tapping the stems with fingers slowly. Remaining desiccants were finally cleaned by using fine brush and these flowers were kept for storage in transparent and opaque acrylic box (lined with black polythene sheet) to assess the storage quality of dried flowers with different parameters such as fresh weight (g), dry weight (g), moisture loss (%), moisture gain (%), sensory evaluation (colour, shape, texture and over all acceptability) and incidence of storage pest and disease were recorded at 0, 30, 60 and 90 days interval.

Results and Discussion

Dry weight (g) and moisture loss (%) in freshly prepared dried flowers

The influence of stage of harvest and storage method on dry weight of flower (Table 1) during storage period was found to non-significant however, the minimum dry weight of 1.33 g was recorded in T_3 (Half open stage + Silica gel + Hot air oven at 50ºC for 42 hours + Transparent acrylic box) while, it was found maximum (1.78 g) was in the treatment T_2 (Just open stage + Silica gel + Hot air oven at 50ºC for 42 hours + Transparent acrylic box). These results are in accordance Anuroopa *et al.* (2016) [3] recorded minimum dry weight (1.44 g/flower) by subjecting orchid at 50°C for 43 hours in hot air oven by using silica gel as a desiccant and Safeena *et al.* (2006) [12] in rose.

Table 1: Effect of stage of harvest and storage methods on fresh weight, dry weight, moisture loss and moisture gain of dried flower during storage period

Treatments	Fresh weight (g)	Dry weight (g)	Moisture loss (%)	Dry weight (g/flower)				Moisture gain (%)		
				Initial	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	6.97	1.56	77.70	1.56	1.61	1.63	1.63	3.10	4.58	4.58
T_2	7.37	1.78	75.90	1.78	1.84	1.87	1.87	3.20	4.80	4.96
T_3	7.62	1.33	82.52	1.33	1.36	1.38	1.38	2.13	3.27	3.27
T_4	8.16	1.37	83.19	1.37	1.41	1.43	1.43	2.35	3.73	3.73
T_5	8.70	1.40	83.92	1.40	1.44	1.46	1.46	2.69	3.96	3.96
T_6	8.80	1.45	83.53	1.45	1.49	1.51	1.51	2.75	4.06	4.29
S.Em±	0.12	0.07	0.70	0.07	0.08	0.08	0.08	0.17	0.30	0.28
CD at 1%	0.53	NS	3.01	NS	NS	NS	NS	NS	NS	NS
CV	2.68	8.56	1.49	8.56	8.65	8.56	8.55	10.65	12.82	11.84

Treatment details

* DAS - Days after storage.

T_1 - $H_1D_1I_2$ (Just open stage + Silica gel + Hot air oven at 50 ºC for 42 hours) + Transparent acrylic box

T_2 - $H_1D_1I_2$ (Just open stage + Silica gel + Hot air oven at 50 ºC for 42 hours) + Opaque acrylic box

T_3 - $H_2D_1I_2$ (Half open stage + Silica gel + Hot air oven at 50 ºC for 42 hours) + Transparent acrylic box

T_4 - $H_2D_1I_2$ (Half open stage + Silica gel + Hot air oven at 50 ºC for 42 hours) + Opaque acrylic box

T_5 - $H_3D_1I_2$ (Petal intact stage + Silica gel + Hot air oven at 50 ºC for 42 hours) + Transparent acrylic box

T_6 - $H_3D_1I_2$ (Petal intact stage + Silica gel + Hot air oven at 50 ºC for 42 hours) + Opaque acrylic box

The interaction between the stage of harvest and method of storage with respect to moisture loss per cent was found to be significant. The moisture loss per cent of the dried flowers was found to be maximum (83.92%) when petal intact stage flowers were dried and stored in transparent acrylic box while, it was found minimum (75.90%) in the flowers which are dried at just open stage and stored in opaque acrylic box. The difference in moisture loss per cent might be due to differences in stage of harvest, structure, bio mass, moisture content and surface area of the flower. In case of petal intact stage, petals are loosely and widely arranged thus it felicitates to accommodate more amount of embedding medium between their space which in turn results in maximum removal of moisture from it when compare to just open stage. The above findings are in agreement with Safeena *et al.* (2006) [12] in rose where, the maximum moisture loss (65.93%) was recorded when half opened flower are subjected to drying in hot air oven at 40 °C for 49 hours by embedding them in silica gel.

Dry weight (g) and moisture gain (%) of the flower at different interval (g)

Data regarding dry weight of the flower as influenced by the treatment and storage period was found to be non-significant (Table 1). However, the minimum dry weight (1.33, 1.36, 1.38 and 1.38 g) was recorded in half open stage flower were kept in transparent acrylic box whereas, it was found maximum (1.78, 1.84, 1.87and 1.87 g respectively) in the treatment combination having just open stage and storage of dried flower in opaque acrylic box) during Initial, 30, 60 and 90 days after storage respectively. Even though the results were found to be non-significant but, the data which is represented in Table 1 shows that there was a gradual increase in dry weight of the flower during initial days of storage this might be due to hygroscopic nature of dried flowers tends to absorb moisture from the surrounding and after 60 to 90 days of storage there was no change in dry weight of the flower irrespective of the stage of harvest and storage material.

The moisture gain per cent the dried flower as influenced by stage of harvest and storage period was found to be non-significant whereas, the minimum moisture gain (2.13, 3.27 and 3.27%) by the dried flower was noted in half open stage flower were kept in transparent acrylic box whereas, maximum (3.20, 4.80 and 4.96%) moisture gain was observed in treatment having just open stage and stored in opaque acrylic box during storage period (30, 60 and 90 days after drying).There is a gradual increase in gaining of the moisture by dried flower this is because of the fact that immediately after dehydration flower become hygroscopic in nature that, in turn tends to absorb the atmospheric moisture up to certain period of time (initial, 30 and 60 DAS) and it become saturate (60 to 90 DAS). Misra *et al*., (2009) [7] stated that, the dried zinnia flowers stored within glass or plastic or acrylic container by keeping small amount silica gel at the bottom of container will preserve the colour and shape for longer period of time by making it more durable and moisture resistant.

Visual quality parameters of the dried flowers as influenced by stage of harvest and storage method on the keeping quality of the dried flowers

The maximum sensory score for colour (8.36, 8.30, 8.23 and 8.10), shape (8.27, 8.15, 8.02 and 7.98), texture (8.28, 8.19, 8.10 and 7.94) and over all acceptability (8.22, 8.05, 8.03 and 7.89) of dried flower during storage period (Initial, 30, 60 and 90 DAS respectively) was recorded in half open stage flowers kept in opaque acrylic box while, it was found to be minimum colour (7.58, 7.39, 7.29 and 7.08), shape (7.50, 7.42, 7.36 and 7.28), texture (7.44, 7.40, 7.13 and 7.08) and over all acceptability (7.35, 7.24, 7.19 and 6.98) in just open stage flower which are kept in opaque acrylic box. Data in Table 2 and Table 3 clearly states that, the score for colour, shape, texture and overall acceptability was decreased gradually with the advancement of storage period and this trend was found to be maximum in the dried flower which is kept transparent acrylic box this is because of its transparency and incidence of direct light leads to fading of colour. In case of opaque acrylic box (lined with black polythene sheet) colour fading was comparatively less this might be due to fact that, black colour absorb the incident light leads to build up of moisture inside the box results in reabsorbing moisture by the dried flower. However, during storage period (Initial, 30 and 60 days after drying) there was no significant difference in colour of the dried flower was observed in the present study (Table 2 to Table 3). This is in agreement with Datta (1999) [6] where, he stated that dry flowers must be kept in moisture barrier containers such as glass vials, acrylic boxes and cardboard

boxes coated with plastic film or wax paper because dried flowers are highly hygroscopic in nature so they tend to absorb atmospheric humidity and lose their shape and these containers should be free from dust and it should be protected from direct sunlight in order to retain its colour similarly, Shirin in 2011 reported that various packaging techniques had a major impact on the overall quality of exotic flowers during storage and flowers which are stored in airtight plastic containers claimed to be better than those kept in polythene covers with respect to colour retention, texture and shape during storage.

Table 2: Effect of stage of harvest and storage methods on colour and shape of the dry flower as assessed through sensory evaluation at Initial, 30, 60 and 90 DAS

Treatments	Colour				Shape			
	Initial	30 DAS	60 DAS	90 DAS	Initial	30 DAS	60 DAS	90 DAS
T_1	7.58	7.39	7.29	7.08	7.50	7.42	7.36	7.28
T_2	7.71	7.61	7.50	7.26	7.77	7.75	7.65	7.60
T_3	8.34	8.16	8.14	8.03	8.24	8.13	8.01	7.95
T_4	8.36	8.30	8.23	8.10	8.27	8.15	8.02	7.98
T_5	8.11	7.94	7.88	7.72	7.99	7.94	7.80	7.74
T_6	8.17	8.02	7.95	7.78	8.13	8.04	7.94	7.77
S.Em±	0.14	0.19	0.18	0.18	0.15	0.11	0.11	0.11
CD at 1%	NS	NS	NS	NS	NS	NS	NS	NS
CV	3.11	4.21	3.92	4.13	3.17	2.42	2.55	2.56

* Treatment details
* DAS - Days after storage.
T_1 - $H_1D_1I_2$ (Just open stage + Silica gel + Hot air oven at 50º C for 42 hours) + Transparent acrylic box
T_2 - $H_1D_1I_2$ (Just open stage + Silica gel + Hot air oven at 50 º C for 42 hours) + Opaque acrylic box
T_3 - $H_2D_1I_2$ (Half open stage + Silica gel + Hot air oven at 50º C for 42 hours) + Transparent acrylic box
T_4 - $H_2D_1I_2$ (Half open stage + Silica gel + Hot air oven at 50º C for 42 hours) + Opaque acrylic box
T_5 - $H_3D_1I_2$ (Petal intact stage + Silica gel + Hot air oven at 50º C for 42 hours) + Transparent acrylic box
T_6 - $H_3D_1I_2$ (Petal intact stage + Silica gel + Hot air oven at 50º C for 42 hours) + Opaque

Table 3: Effect of stage of harvest and storage methods on texture and over all acceptability of dried flower as assessed through sensory evaluation at Initial, 30, 60 and 90 DAS

Treatments	Texture				Over all acceptability			
	Initial	30 DAS	60 DAS	90 DAS	Initial	30 DAS	60 DAS	90 DAS
T_1	7.44	7.40	7.13	7.08	7.35	7.24	7.19	6.98
T_2	7.66	7.55	7.46	7.38	7.73	7.69	7.56	7.18
T_3	8.19	8.13	8.02	7.90	8.11	7.96	7.92	7.82
T_4	8.28	8.19	8.10	7.94	8.22	8.05	8.03	7.89
T_5	7.86	7.79	7.52	7.33	7.96	7.85	7.73	7.67
T_6	7.96	7.94	7.77	7.75	7.98	7.87	7.76	7.73
S.Em±	0.14	0.14	0.17	0.15	0.17	0.20	0.31	0.21
CD at 1%	NS	NS	NS	NS	NS	NS	NS	NS
CV	3.08	3.10	3.77	3.33	3.63	4.54	6.94	4.91

Treatment details
* DAS - Days after storage.
T_1 - $H_1D_1I_2$ (Just open stage + Silica gel + Hot air oven at 50 º C for 42 hours) + Transparent acrylic box
T_2 - $H_1D_1I_2$ (Just open stage + Silica gel + Hot air oven at 50 º C for 42 hours) + Opaque acrylic box
T_3 - $H_2D_1I_2$ (Half open stage + Silica gel + Hot air oven at 50 º C for 42 hours) + Transparent acrylic box
T_4 - $H_2D_1I_2$ (Half open stage + Silica gel + Hot air oven at 50 º C for 42 hours) + Opaque acrylic box
T_5 - $H_3D_1I_2$ (Petal intact stage + Silica gel + Hot air oven at 50 º C for 42 hours) + Transparent acrylic box
T_6 - $H_3D_1I_2$ (Petal intact stage + Silica gel + Hot air oven at 50 º C for 42 hours) + Opaque acrylic box

Pest and disease incidence during storage

There was no any incidence of pest and diseases were recorded during storage period may be due to the dried flowers are handled with greatest care by placing the small sachets of silica gel at the bottom of the container to absorb moisture from the surrounding and periodical monitoring of storage box to check the incidence of pest and diseases. The above statement is in agreement with Plomaritis (2004) [8] has recommended to store the dried material by keeping naphthalene flakes and few moth balls to protect from insect and mould growth. Dried flowers should be sealed in airtight containers such as tins or plastic boxes, sealed with masking tape or sealed cupboard boxes enclosed in airtight plastic bags for extended use.

Conclusion

It was evidenced from the present study that, the sensory score for colour, shape, texture and over all acceptability for dried flower during storage period as influenced by stage of harvest and storage method was found to be maximum when it is dried at half open stage flowers in hot air oven at 50º C for 42 hours by embedding them with silica gel and kept for storage in transparent acrylic box.

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