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Evaluation of drying method and suitable variety of dutch roses for quality dried flower production

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Abstract: The present study was carried out to evaluate the best drying method for quality dried Dutch rose flower production with suitable variety in the laboratory of RHREC, COH Bangalore Karnataka, during the year of 2014-15. The treatment comprised of four Dutch varieties, V_1 – TajMahal, V_2 - Gold Strike, V_3 – Noblesse, V_4 – Avalanche and two drying methods- D_1 - Air drying, D_2 - Hot air-oven were replicated thrice in two factorial completely randomized design. The results from the findings indicated that, Among the drying methods, hot air oven dried flowers recorded minimum dry weight (2.24 g), (2.27 g) and (2.27 g) at zero,30 and 60 days after storage maximum moisture loss (79.83%) and least time (49.40 hours) for drying than air drying. Among varieties dried by different drying methods, var. Gold Strike recorded minimum dry weight (2.51 g), (2.63 g) and (2.64 g) at zero, 30 and 60 days after storage with maximum moisture loss (76.29%) and minimum (117.03 hours) time for drying. Among the drying methods, var. Taj Mahal of hot air oven drying method recorded maximum score for colour (22.20),(22.10) and (22.00), texture (21.57), (21.27) and (21.07), shape (23.61), (23.41) and (23.11) and overall appearance (22.56), (22.26) and (22.06) at zero days, 30 days and 60 days after storage with least dry weight of (2.24 g) with maximum moisture loss of 79.83 per cent in minimum time (49.40 hours) in hot air oven. Minimum moisture gain was observed in hot air oven drying method (0.27% and 0.27%) at 30 and 60 days after storage.

Key words: Dutch rose, Hot air oven, Moisture loss and gain, Quality parameters.

Introduction

Value addition means consumers are willing to pay more than they would for a raw product. Flower preservation is as early as the history of man, although deliberate flower preservation is a more recent phenomenon. Many value added products can be made from dried flowers such as collages, flower pictures, flower balls, greeting cards, covers, pomanders, festive decorations, bouquets and wreaths, sweet-smelling pot pourries, etc. (Raghupathy *et al*., 2000). The flowers or leaves are embedded in a drying medium, sand, silica gel or borax depending upon the plant material. These materials cover flowers in such a way that the original shape of the flower is maintained without altering its original shape (Bhattacharrjee and De, 2003). The literature available on drying techniques is mostly related to the flora and fauna of temperate regions. But, nearly 60 per cent of raw material is obtained from natural geographic land that lies close to western, eastern and northern Himalayan ghats and plains, while remaining 40 per cent of the flowers are exclusively cultivated for dry flower industry employing nearly one lakh people (Raju, 2002).

Catching sight of flowers growing in all their grandeur and simplicity makes it tempting to wish the season would go on and that the flowers never fade. In such an attempt, different methods for drying and dehydrating plant materials have been tried to retain their colour and form for a very long period (Bhutani, 1990). Desiccants like sand, borax, silica gel, saw dust, perlite and combination of these are used as media for embedding. Among these sand and borax are cheaper but they take more time for drying. For delicate flowers like roses, dahlia, carnation, gerbera etc., silica gel is the ideal drying agent (Prasad *et al*., 1997). Now a day's hot air and microwave ovens are also being used for faster drying and to improve the quality of dry flowers. In these methods, plant material is kept at controlled temperature for a specified time according to the plant species. In the present investigation efforts have been made to find out the best dying method for quality dried Dutch rose flowers with relation to the suitable variety.

Materials and Methods

The experiment was laid out in two factorial completelty randomized design (CRD) with sixteen treatments replicated 3 times, during 2014-2015 in the laboratory of Department of Floriculture and Landscape Architecture, Regional Horticultural Research Extension Centre Bengaluru, College of Horticulture, Bengaluru. Rose varieties used for the present study were Taj Mahal (Red), Avalanche (White), Gold Strike (Yellow) and Noblese (Pink) dried in hot air oven using silica gel (60- 120 mesh), microwavable containers and acrylic air tight storage containers.

Cultivars and their description: The four cultivars and their description include:

Variety	Characters
Taj Mahal	Deep red colour with large size flowers and long stalks
Gold Strike	Dark yellow colour, large head size and high petal count
Noblesse	Medium sized pink flower
Avalanche	True eggshell white colour, large bloom and gentle edges

All the above four cultivars belong to the class of Hybrid Teas. Main characteristics of these cultivars are production of blooms on long canes, elongated buds and slow opening of flowers (Arora, 1990).

The stages of harvest were fixed based on the nature of crop growth and flower development. Two stages of harvest namely, tight bud stage and half bloom stage among this in our experiment half bloom stage was assessed under each variety based on the earlier literature, at which drying is perfect to retain colour, shape and the visual quality at its best. Half bloom stage is that when around fifty per cent of the petals are open. Flower buds took fourteen to sixteen days from bud appearance to reach this stage. Experiment was carried out to find the best method among Air drying and Hot air oven drying. In air dying a sample size of five flowers per replication of four varieties were tied separately using thread and hanged upside down in the room with good ventilation and left for seven to twelve days for dying. In another method, by using hot air oven at 40^0C with silica gel as an embedding material was used to dry the flowers at a uniform drying rate. Here a sample size of five flowers per replication of all four varieties was used.

Sensory evaluation of dried Dutch rose flowers: Flower colour retention after drying is one of the qualitative character to judge overall appearance of the dried flowers. Data pertaining to the response of different varieties of Dutch roses to different temperature levels has assessed based on the sensory evaluation using 25 point scale with the weightage of 21-25 as very good, 16-20 as good, 11-15 as average, 6-10 as poor and 0-5 as very poor. Later the dried flowers were assessed for their quality by using sensory evaluation method at zero days after storage (DAS), 30 and 60 DAS. The data obtained was analysed statistically as suggested by Sunderraj *et al*. (1972).

Results and Discussion

The data pertaining to the dry weight among the varieties screened for dry flower making at zero, 30 and 60 days after storage, significantly highest dry weight (3.58 g) , (3.69 g) and (3.71 g) were recorded by Dutch rose var. Taj Mahal. Whereas, it was minimum in var. Gold Strike (2.51 g), (2.92 g) and (2.64 g). Among the drying method, dry weight was significantly highest under air drying (3.64 g), (3.88 g) and (3.90 g) however it was lowest under hot air oven (2.24 g), (2.27 g) and (2.27 g) drying method. (Table 1). The results were consonance with the findings of Kulkarni *et al*. (2004), observed that among the different drying methods like sun, shade and hot air oven drying methods, oven drying was the best. Highest dry weight at zero days after storage was in V_1D_1 (var. Taj Mahal x Air drying) (4.56 g), (4.77 g) and (4.80 g) treatment combination. Whereas, it was lowest (1.86 g), (1.89 g) and (1.89 g) in V_2D_2 (var. Gold Strike x Hot air oven) treatment combination. Similarly Meeteren (1988) has stated that variation in dry weight of varieties is attributed to the differences in genetic characters of the varieties. These results are in agreement with the results of Salma *et al.* (2012) in Dendrobium orchid flowers. (Table 2). This is in agreement with the findings of Kaur (1999), observed that air drying mainly depends on prevailing climatic conditions. Among the different drying methods like sun, shade and hot air oven drying methods, oven drying proved better Kulkarni *et al*. (2004). (Table 2).

Table-1: Fresh weight, dry weight, moisture loss and time taken for drying Dutch roses as influenced by the drying method

Treatments	Fresh wt. (g/ flower)	Dry wt. (g/ flower)	Moisture loss (%)	Drying duration (hrs)
Variety(V)				
V_1 - Taj Mahal	13.53	3.58	73.62	150.17
V_2 - Gold Strike	10.62	2.51	76.29	117.03
V_3 - Noblesse	11.11	2.79	74.94	124.09
V_4 - Avalanche	9.73	2.88	70.52	139.03
S. Em±	0.09	0.06	0.59	1.81
C.D. at 5%	0.28	0.17	1.76	5.43
C.D. at 1%	0.39	0.24	2.42	7.48
Drying method (D)				
D_1 - Air drying	11.30	3.64	67.85	215.76
D_2 - Hot air-oven	11.19	2.24	79.83	49.40
S. Em±	0.07	0.04	0.41	1.28
C.D. at 5%	NS	0.12	1.24	3.84
C.D. at 1%	NS	0.17	1.71	5.29
Interaction effect (V x D)				
V_1D_1 - Taj Mahal x Air drying	13.73	4.56	66.77	250.96
V_1D_2 - Taj Mahal x Hot air oven	13.33	2.59	80.47	49.37
V_2D_1 - Gold Strike x Air drying	10.53	3.16	70.02	185.68
V_2D_2 - Gold Strike x Hot air oven	10.7	1.86	82.56	48.38
V_3D_1 - Noblesse x Air drying	11.02	3.34	69.92	198.80
V_3D_2 - Noblesse x Hot air oven	11.2	2.24	79.95	49.38
V_4D_1 - Avalanche x Air drying	9.93	3.51	64.68	227.60
V_4D_2 - Avalanche x Hot air oven	9.53	2.25	76.35	50.47
S. Em±	0.13	0.08	0.83	2.56
C.D. at 5%	NS	0.24	NS	7.68
C.D. at 1%	NS	0.34	NS	10.58

DAS- Days after storage, '0' DAS (zero days) *i.e.,* immediately after drying of flowers

Moisture loss (%): There was significant difference observed for per cent moisture loss during drying of Dutch rose varieties. Maximum moisture loss 76.29 per cent was recorded in var. Gold Strike. Maximum moisture loss was recorded (79.83%) under hot air oven drying. While it was minimum (67.85%) under air drying method. This is because in hot air oven, plant material is kept at controlled temperature for a specified time typical of the plant species. Temperature plays an important role in drying of flowers and other ornamental plant parts by influencing both qualitative and quantitative parameters. At higher temperature, as proposed by Mayak and Halevy (1980), the rate of transpiration was comparatively much higher than lower temperature levels. (Table 1).

Drying duration (hours): Among varieties of Dutch roses, with respect to duration of drying of var. Gold Strike took lowest hours for drying (117.03 hours). Whereas, the var. Taj Mahal took maximum duration (150.17 hours) for drying compared to rest of the varieties. Similar trend was reported by White *et al.* (2002) (Table 1). Among drying methods, flowers dried under hot air oven took significantly least drying duration of 49.40 hours and it was highest in air drying

Table-2: Dry weight, moisture loss and time taken for drying Dutch roses as influenced by the drying method during storage periods

Treatments	Dry weight (g/flower)			Moisture	Moisture gain (%)	
	'0' DAS	30 DAS	60 DAS	loss (%)	30 DAS	60 DAS
Variety (V)						
V_1 - Taj Mahal	3.58	3.69	3.71	73.62	0.84	0.94
V_2 - Gold Strike	2.51	2.63	2.64	76.29	1.18	1.11
V_3 - Noblesse	2.79	2.92	2.94	74.94	1.29	1.12
V_4 - Avalanche	2.88	3.04	3.05	70.52	1.63	1.70
S. Em±	0.06	0.06	0.06	0.59	0.21	0.32
C.D. at 5%	0.17	0.17	0.17	1.76	NS	NS
C.D. at 1%	0.24	0.24	0.23	2.42	NS	NS
Drying method (D)						
D_1 - Air drying	3.64	3.88	3.90	67.85	2.20	2.17
D_2 - Hot air-oven	2.24	2.27	2.27	79.83	0.27	0.27
S. Em±	0.04	0.04	0.04	0.41	0.15	0.23
C.D. at 5%	0.12	0.12	0.12	1.24	0.44	0.68
C.D. at 1%	0.17	0.17	0.16	1.71	0.60	0.94
Interaction effect (V x D)						
V_1D_1 - Taj Mahal x Air drying	4.56	4.77	4.80	66.77	1.54	1.74
V_1D_2 - Taj Mahal x Hot air oven	2.59	2.61	2.61	80.47	0.14	0.14
V_2D_1 - Gold Strike x Air drying	3.16	3.37	3.39	70.02	2.09	1.95
V_2D_2 - Gold Strike x Hot air oven	1.86	1.89	1.89	82.56	0.26	0.26
V_3D_1 - Noblesse x Air drying	3.34	3.57	3.60	69.92	2.29	1.96
V_3D_2 - Noblesse x Hot air oven	2.24	2.28	2.28	79.95	0.28	0.28
V_4D_1 - Avalanche x Air drying	3.51	3.79	3.81	64.68	2.88	3.02
V_4D_2 - Avalanche x Hot air oven	2.25	2.29	2.29	76.35	0.38	0.38
S. Em±	0.08	0.08	0.08	0.83	0.29	0.45
C.D. at 5%	0.24	0.24	0.24	NS	NS	NS
C.D. at 1%	0.34	0.33	0.33	NS	NS	NS

DAS- Days after storage. '0' DAS (zero days) *i.e.,* immediately after drying of flower

(215.76 hours). Significant difference was reported for interaction effect between varieties and drying methods with respect to drying duration. The treatment combination V_2D_2 (Gold Strike x Hot air oven) (48.38 hours) recorded lowest drying duration. Whereas, it was significantly highest in V_1D_1 (var. Taj Mahal x Air drying) treatment combination (250.96 hours). This might be due to the influence of surrounding weather factors such as temperature and relative humidity during air drying as stated by White *et al.* (2002) more fleshy flowers and foliage took more time for drying and rose bunches could be hung dried in shade within 5-10 days. (Table 1).

Moisture gain (%): Significant difference was recorded for moisture gain with respect to different drying methods at 30 and 60 days after storage. At 30 and 60 days after storage, minimum moisture gain was observed in hot air oven drying method (0.27% and 0.27%) respectively. Whereas, it was maximum in air drying (2.20% and 2.17%) respectively. This might be due to the effect of the storage conditions, as hot air oven dried flowers were kept in air tight acrylic containers whereas air dried flowers were kept in open environment conditions without air tight containers (Table 2).

Quality attributes of dried flowers of Dutch rose varieties as influenced by drying methods: Quality attributes of dried flowers of Dutch rose varieties as influenced by the drying methods, among two drying methods, flowers dried by using hot air oven scored significantly higher points for all the quality parameters when compared to air drying which had scored the least. Blue and yellow flowers retain their colour when air dried but pink flowers fade. The probable reason for this might be due to the controlled temperature of the hot air oven for a specified time. Oven drying of china aster flowers was the best for retention of original colour, shape and texture of dried flowers (Raju and Jayanthi, 2002).

Among varied treatment combinations of varieties and drying methods at zero days after storage rose var. Taj Mahal dried under hot air oven with the drying duration of 49.37 hours scored highest sensory score of 22.20 points with respect to flower colour. Whereas, varieties dried under air drying method obtained lowest sensory score of 5.21 points by var. Avalanche. Supporting results were reported by Kher and Bhutani (1979), who observed that embedded drying method yielded best quality dry flowers in terms of colour, appearance, texture and shape. This might be due to reason that the flowers embedded in desiccant like silica gel in turn maintained the original shape and appearance of the flower (Table 3).

Interaction between varieties and drying methods with respect to flower shape at zero days after storage, rose var. Taj Mahal dried under hot air oven with the drying duration of 49.37 hours scored highest sensory score of 23.61 points for shape. Whereas, variety dried under air drying method obtained lowest sensory score of 4.30 by var. Avalanche. Among treatment combinations of varieties and drying methods with respect to flower texture at zero days after storage, rose var. Taj Mahal dried under hot air oven with the drying duration of 49.37 hours scored highest sensory score of 21.57 points. Whereas, varieties dried under air drying method obtained lowest sensory score of 4.14 by var. Avalanche respectively. Interaction between varieties and drying methods with respect to overall appearance at zero days after storage, rose var. Taj Mahal dried under hot air oven with the drying duration of 49.37 hours scored highest sensory score of 22.56 points. Whereas, varieties dried under air drying method obtained lowest sensory score of 4.55 by var. Avalanche respectively. (Table 3). This is in conformity with the findings of Dhatt *et al*. (2007).

At 30 days after drying, the rose var. Taj Mahal dried under hot air oven scored highest sensory score of 22.10 points with respect to the flower colour. Whereas, rest of the varieties *viz.,* Taj Mahal, Noblesse, Gold Strike and Avalanche dried under air drying method obtained lowest sensory score of 9.37, 6.14, 5.87 and 4.21 respectively. Similarly Dutch rose flowers of var. Taj Mahal dried under hot air oven scored highest sensory score of 23.41 points with respect to shape. Whereas, varieties dried under air

Table-3: Influence of drying methods on colour, shape, texture and overall appearance of dried Dutch rose flowers as assessed through sensory evaluation during storage periods

Treatments	Colour			Shape			Texture			Overall appearance		
	'0' DAS	30 DAS	60 DAS	'0' DAS	30 DAS	60 DAS	'0' DAS	30 DAS	60 DAS	'0' DAS	30 DAS	60 DAS
V_1D_1 - Taj Mahal x Air drying	10.30	9.37	8.28	9.20	8.10	7.20	6.31	5.97	5.05	8.21	7.28	7.00
V_1D_2 - Taj Mahal x Hot air oven	22.20	22.10	22.00	23.61	23.41	23.11	21.57	21.27	21.07	22.56	22.26	22.06
V_2D_1 - Gold Strike x Air drying	6.07	5.87	5.57	5.17	5.07	4.94	5.08	4.98	4.58	5.65	5.60	5.30
V_2D_2 - Gold Strike x Hot air oven	20.34	20.16	20.06	20.07	20.06	20.01	20.07	19.96	19.86	20.05	19.96	19.76
V_3D_1 - Noblesse x Air drying	7.24	6.14	5.94	5.08	4.88	4.68	5.34	5.14	4.74	6.31	6.11	5.91
V_3D_2 - Noblesse x Hot air oven	21.57	21.37	21.07	20.64	20.44	20.24	20.27	20.17	20.05	21.30	21.10	21.05
V_4D_1 - Avalanche x Air drying	5.21	4.21	4.05	4.30	4.10	4.00	4.14	4.05	3.95	4.55	4.25	4.04
V_4D_2 - Avalanche x Hot air oven	18.33	18.05	17.87	17.61	17.31	17.11	18.08	17.98	17.88	18.17	18.07	17.07

25-point scale with the weightage of i.e., 21-25 very good, 16-20 good, 11-15 average, 6-10 poor and 0-5 very poor. DAS- Days after storage. '0' DAS (zero days) i.e., immediately after drying of flowers

drying method obtained lowest sensory score 4.10 by var. Avalanche. Similarly Dutch rose flowers with respect to the flower texture var. Taj Mahal dried under hot air oven scored highest sensory score of 21.27 points. Whereas, varieties dried under air drying method obtained lowest sensory score of 4.05 by var. Avalanche. In case of Dutch rose flowers with respect to overall appearance var. Taj Mahal dried under hot air oven scored highest sensory score of 22.26 points. However, varieties dried under air drying method obtained lowest sensory score of 4.25 recorded in var. Avalanche, probable reason is that the air dried flowers become shrivel and become darker. Brighter roses become even darker, while white roses become a yellow parchment colour. Supporting results were reported by Kher and Bhutani (1979). At 60 days after drying of flowers the rose var. Taj Mahal dried under hot air oven maintained highest sensory score of 22.00 points with respect to colour retention. Whereas, variety dried under air drying method obtained lowest sensory score of 4.05 points by var. Avalanche. Similarly with respect to flower shape, Dutch rose flowers var. Taj Mahal dried under hot air oven maintained highest sensory score of 23.11 points. Whereas, other varieties dried under air drying method obtained lowest sensory score of 4.00 by var. Avalanche. With respect to flower texture var. Taj Mahal dried under hot air oven maintained highest sensory score of 21.07 points. However varieties dried under air drying method obtained lowest sensory score 3.95 by var. Avalanche. Similarly in var. Taj Mahal dried under hot air oven maintained highest sensory score of 22.06 points with respect to overall appearance. (Table 3). Whereas, variety dried under air drying method obtained lowest sensory score of 4.04 by var. Avalanche. Similar findings was reported by Raju and Jayanthi (2002), observed that oven drying of china aster flowers was the best for retention of original colour, shape and texture of dried flower. It is evident from the present findings that, hot air oven drying proved as faster drying method to improve the quality of dry flowers. Silica gel acts as best desiccant when compared to other embedding materials. This is in conformity with the findings of Peggy (1978).

Based on the results of the Experiment conducted, hot air oven method can be chosen for further studies to determine the optimum time and also to find out the best suitable variety for drying at varied temperature levels.

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