The Bioscan 13(4):869-873,2018
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EVALUATION OF DIFFERENT DRYING METHODS FOR ORNAMENTALS BASED ON ACCEPTABILITY AND STORAGE OF DRIED PLANT PRODUCTS

SHALINI JHANJI*, PARMINDER SINGH, K. K. DHATT AND H. S. GREWAL
Department of Floriculture and Landscaping,
Punjab Agricultural University, Ludhiana - 141 001, INDIA
e-mail: shalinijhanji@pau.edu

KEYWORDS
Drying techniques, Ornamentals, Preservation, Acceptability, Storage, Value Addition

Received on :
20.03.2018

Accepted on :
22.10.2018

***Corresponding author**

ABSTRACT
Dried ornamental products have novelty, longevity, flexibility and year round availability. The present study was conducted to standardize the drying methods for ornamental plants viz. flowers of Gomphrena, panicles of Golden Rod and peduncles of Golden Rain Tree. The plant parts were subjected to vertical, inverted and water drying and it was found that inverted drying took least time (4-5 days) for drying and least moisture retention after drying . The flowers of Gomphrena dried by inverted drying scored 10,10 and 8.89 respectively, for colour, shape and texture retention whereas the corresponding values were 8.44, 7.67 and 7.22, respectively for Golden Rod and 10, 9.11 and 7.22, respectively for Golden Rain Tree. The overall acceptability of all three ornamentals based on these parameters was found to be the best for inverted drying. The dried plant parts could be stored for more than 6 months with high acceptability score of 8.80, 7.40 and 8.67 respectively for Gomphrena, Golden Rod and Golden Rain Tree . Thus, the flowers of Gomphrena/ panicles of Golden rod/ peduncles of Golden Rain Tree can be dried best by hanging in inverted position in well ventilated dark room for 4-5days and can be used upto 6 months.

INTRODUCTION

Floriculture, a developing agro industry, is expanding at a very fast pace globally and the floral basket includes fresh cut flowers, live plants, fresh bulbs and foliages, seeds , dry flowers, etc (Shivayya *et al*., 2015 and Vishnupriya and Jawaharlal, 2014). Among these, the demand of dried floral product has grown exponentially due to eco-consciousness of consumers (Datta and Roy, 2011). The total floricultural export from India comprises of 71% of dried flowers (De *et al*., 2016).There is a range of plant parts such as roots, shoots, stems, foliage, bracts, buds, flowers, inflorescences, fruiting shoots, fruit peel, cones, seeds, thorns, barks or lower plants such as lichens, fleshy fungi, mosses and selaginella that can be dried and serve as floral products (Deshraj, 2001). Dried floral products can be used in many ways like bouquets, flower arrangements, collages, wall décor, flower pictures, greeting cards, candles, sweet scented pot pourries etc.

The dried floral products being long lasting overwhelm the limitations of fresh flowers' utility. The fresh floral products are expensive, perishable and have limited availability throughout the year whereas dried floral products are comparatively inexpensive and have everlasting value with year around availability (Safeena *et al*., 2006). Dried floral products can survive the heat of summer and cold of winter (Bhalla *et al*., 2006). After drying, the charm of ornamental flowers could be enjoyed for several years without disturbing their colour and form (Ranjan and Misra, 2002).

Drying is the simplest way for post-harvest preservation of plants or its parts as it enables conservation of plant material qualities in an uncomplicated manner. The flower drying techniques involve reducing moisture content of flowers to a point at which biochemical changes are minimized while maintaining cell structure, pigment level and flower shape (Singh *et al*., 2003). Drying technique is the determinant of the final quality of dry flower product. Different drying techniques like air, desiccant, oven, freeze, water, humectant etc are used to dry different flowers, foliages, seeds, fruits or pods but each floral product could be dried with best retention of colour, shape and texture using a specific technique (Singh and Suman, 2017). To produce best quality of decorative items and value added products, standardization of drying technique for different plant parts is necessary. Further, the life of dried floral product varies according to species, texture of their petal and total consistency of flower (Safeena and Patil, 2013).

There is a wide range of wild ornamental flora that could be exploited for generation of value added dried products with very low inputs. This demands for systematic study to explore different plant parts that could be dried through different techniques with least reduction in their quality for their utility in different floral products. The apparent dearth of information in exploration of wild flora and standardization of drying technique demand for increased scientific investigation and rapid progress towards this innovative process This component of floriculture industry has a large potential for

generating job opportunities to thousands of unemployed men and women for entrepreneurship development.

Keeping in view, the importance and increasing demand of dried floral products; availability of range of unexplored wild flora and different techniques for drying of different plant parts , the present study was planned to standardize the drying technique for different parts of three ornamentals viz. flowers of Gomphrena, panicles of Golden Rod and peduncles of Golden Rain Tree.

MATERIALS AND METHODS

The present study was conducted to evaluate the drying techniques for different parts of ornamentals viz. flowers of Gomphrena, panicles of Golden Rod and peduncles of Golden Rain Tree and record their acceptability after drying during storage period of six months. The plant material was harvested from the Fields of Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana.

Stage and time of harvest

(i) Gomphrena

Gomphrena is a summer annual and blooms in the month of July and August. Fresh flowers were harvested at fully open stage in the fourth week of July and first week of August and dried.

(ii) Golden rod

Golden Rod is a perennial shrub and come to bloom with beautiful yellow flowers during the month of September and October. The panicles having flowers at half open stage were harvested in the fourth week of September and first week of October and dried.

(iii) Golden rain tree

Golden Rain Tree is a deciduous tree that produces panicles of yellow flowers in the month of August and September. The fruit is a three-parted inflated bladder like pod that ripens from green to orange to pink in autumn. The peduncles having mature pods were harvested in the first and third week of October and dried.

Methods of drying

The plant parts of different ornamentals were dried with following methods (Verma *et al*., 2012 and Brown, 2013)

(i) Inverted drying: The plant materials of good quality were selected, tied in bunches and then hung in inverted or upside down position in ventilated dark room for drying. Drying in direct sunlight should be avoided as it causes discolouration.

(ii) Vertical drying: The plant materials of good quality were selected, tied in bunches and then kept upright in ventilated dark room for drying.

(iii) Water drying: The plant materials having good quality were selected, placed in water and then allowed to dry along with evaporation of water.

Observations were recorded for time taken for drying, loss in weight after drying (Gupta, 1999). The sensory evaluation for colour {using RHS (Royal Horticultural Society) chart, C}, shape (S) and texture (T) retention was done on the score from 1-10 (where each one unit corresponds to 10%). The shattering after drying treatments was done by drop method and the extent of shattering (Sh) was recorded with same score card of 1-10. Based on all above parameters, overall acceptability of a method was calculated using formula {C + S + T + (10-Sh)}/4. All the above mentioned observations were recorded after drying at monthly interval during storage period of six months. The acceptability was calculated after every month on the basis of colour, shape, texture and extent of shattering using the same formula {C + S + T + (10-Sh)}/4.

RESULTS AND DISCUSSION

Loss in weight

The weight declined significantly after drying following different methods in all the three ornamentals (Table 1). The per cent decline in weight was least in water dried plant parts of all the three ornamentals. The loss in weight after inverted and vertical drying was at par in Gomphrena and Golden Rod but significantly more loss in weight was recorded in vertically dried peduncles of Golden Rain Tree. The variation in loss in weight of ornamentals after drying with different methods might be due to their structural differences (Paul and Joyce, 2005).The loss in weight is considered to be equivalent to moisture content and longevity of dried product with less moisture content is considered to be more. The petals of dried flowers with low moisture content had improved quality (Chen *et al*., 2000). The loss in weight by inverted/vertical drying in different plant parts was more indicating less moisture content in dried product and more longevity of the product (Mathapati *et al*., 2015).

Time taken for drying

There was significant difference in time taken for drying of flowers of Gomphrena following different methods (Table 2). The time taken for drying of panicles of Golden Rod and peduncles of Golden Rain Tree by inverted and vertical drying was at par but significantly more by water drying (Table 2). The water drying took 6.64 days for drying of flowers of Gomphrena in comparison to 5.22 days by vertical drying and 4.22 days by inverted drying. The corresponding values for panicles of Golden Rod were respectively 11.78, 4.11 and 4.67 days and for peduncles of Golden Rain Tree were respectively 12.59, 4.71 and 4.46 days. White *et al*. (2002) reported that more fleshy flowers and foliage took more time in drying i.e. the plant parts having less moisture content take less time in dehydration than parts having higher moisture content. Further, the texture of plant parts influences the absorbing capacity of plant tissue which affects the time taken for dehydration (Bale, 2006). The difference in time taken for drying of different plant parts could be explained due to difference in size and density of different plant tissues and variation in method could be accounted to difference in content of moisture loss while drying.

Quality parameters

The plant parts of three ornamentals retained their colour even after drying by all the three methods as depicted by their high score for colour retention that was more than 9 and even 10 for flowers of Gomphrena and peduncles of Golden Rain Tree; and between 7.5 and 8.5 for panicles of Golden Rod (Table 2). Basappa *et al*. (1991) reported retention of colour intensity for maximum number of days in everlasting flowers when air dried at room temperature as compared to other drying

Table 1: Effect of drying technique on of weight loss and time taken for drying of flowers of Gomphrena, panicles of Golden rod and peduncles of Golden rain tree

Drying Technique	Loss in weight (%)			Time taken for drying (days)		
	Gomphrena	Golden rod	Golden rain tree	Gomphrena	Golden rod	Golden rain tree
Inverted	64.70 (53.53)	57.97 (49.57)	62.40 (52.17)	4.31	4.67	4.46
Vertical	62.49 (52.22)	58.50 (49.88)	64.89 (53.66)	5.22	4.11	4.71
Water	56.24 (48.57)	48.48 (44.11)	50.91 (45.51)	6.64	11.78	12.59
CD (P=0.05)	1.398	1.172	1.744	0.459	0.637	1.011

Table 2: Effect of drying technique on of colour and shape retention of flowers of Gomphrena , panicles of Golden rod and peduncles of Golden rain tree after drying

Drying technique	Colour retention			Shape retention		
	Gomphrena	Golden rod	Golden rain tree	Gomphrena	Golden rod	Golden rain tree
Inverted	10.00	8.44	10.00	10.00	7.56	9.11
Vertical	9.56	7.56	9.89	9.44	4.89	6.44
Water	9.22	8.22	9.78	8.22	4.67	5.22
CD (P=0.05)	0.538	0.631	NS	0.426	0.893	0.571

Table 3: Effect of drying technique on texture retention and extent of shattering of flowers of Gomphrena, panicles of Golden rod and peduncles of Golden rain tree after drying

Drying technique	Texture retention			Extent of shattering		
	Gomphrena	Golden rod	Golden rain tree	Gomphrena	Golden rod	Golden rain tree
Inverted	8.89	7.22	7.22	0.00	1.44	1.44
Vertical	7.78	6.44	6.55	0.00	3.00	1.67
Water	7.22	7.22	7.44	0.00	3.22	1.89
CD (P=0.05)	0.539	NS	0.631	NS	0.808	NS

(Score card: 1 < 10%; 2 < 20%.....10 ≤ 100%)

Table 4: Overall acceptability based on colour, shape, texture and shattering extent of dried flowers of Gomphrena during 6 months of storage (Shelf life for 6 months)

Drying technique	Storage duration (months)					
	1	2	3	4	5	6
Inverted	9.33	8.93	8.80	8.80	8.80	8.80
Vertical	9.20	8.67	8.60	8.53	8.46	8.33
Water	9.00	8.53	8.46	8.26	8.13	8.00
CD (P=0.05)	NS	NS	0.133	0.188	0.188	0.133

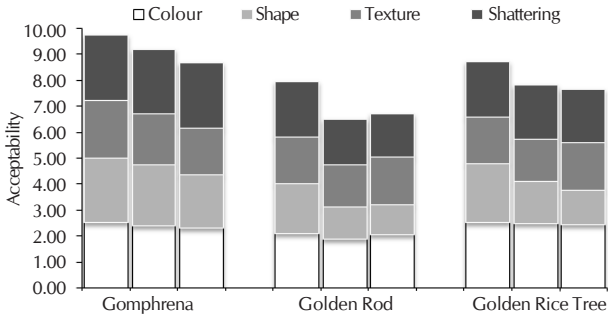

Figure 1: Effect of drying technique on overall acceptabilty of flowers of *Gomphrena*, panicles of Golden rod and peduncles of Golden rain tree after drying

techniques.

The different drying methods significantly influenced the shape of dried part of the three ornamentals (Table 2). Among different drying methods, the dried parts retained their shape with high score after inverted drying and least score after water drying. Among different ornamentals, the flowers of Gomphrena subjected to inverted drying had highest score of 10 followed by 9.44 after vertical drying and 8.22 after water drying. The corresponding scores for shape retention were 9.11, 6.44 and 5.22 for peduncles of Golden Rain Tree and 7.56, 4.89 and 4.67 for panicles of Golden Rod. Although the shape retention score of water dried parts was less except Gomphrena yet the distortion in shape was acceptable.

The flowers of Gomphrena showed significantly high score (8.89) for texture retention after inverted drying in comparison to 7.78 after vertical drying and 7.22 after water drying (Table 3). The scores for shape retention by panicles of Golden Rod did not differ significantly after drying with different methods (Table 3). The shape retention scores for invertedly (7.22) and water (7.44) dried peduncles of Golden Rain Tree were at par but significantly higher than vertically (6.55) dried peduncles (Table 3).

There exists inverse relationship between extent of shattering and acceptability of dried products. Non significant extent of shattering was recorded while drying flowers and peduncles by all the methods (Table 3). The panicles of Golden Rod dried invertedly showed least shattering (1.44) indicating higher acceptability than vertically (3.00) and water (3.22) dried panicles.

Table 5: Overall acceptability based on colour, shape, texture and shattering extent of dried panicles of Golden rod during 6 months of storage (Shelf life for 6 months)

Drying technique	Storage duration (months)					
	1	2	3	4	5	6
Inverted	8.20	8.06	7.67	7.40	7.40	7.40
Vertical	7.20	6.70	6.40	6.00	5.73	5.73
Water	7.56	7.26	6.93	6.53	5.63	5.43
CD (P=0.05)	0.625	0.377	0.754	0.266	0.298	0.293

Table 6: Overall acceptability based on colour, shape, texture and shattering extent of dried peduncles of Golden rain tree during 6 months of storage (Shelf life for 6 months)

Drying technique	Storage duration (months)					
	1	2	3	4	5	6
Inverted	8.98	8.98	8.98	8.67	8.67	8.67
Vertical	8.14	8.00	8.00	8.00	7.67	7.67
Water	8.02	7.67	7.67	7.67	7.33	7.33
CD (P=0.05)	0.219	0.667	0.667	0.262	0.262	0.262

(Score card: 1 < 10%; 2 < 20%.....10 ≤ 100%)

Overall Acceptability

On the basis of sensory evaluation of all above parameters, the overall acceptability of the drying method was calculated [{C+S+T+ (10-B)}/4]. There was significant difference in overall acceptability of dried products after drying with different methods. (Figure1). The inverted drying resulted in high acceptability of 9.72 for flowers of Gomphrena, 7.95 for panicles of Golden Rod and 8.72 for peduncles of Golden Rain Tree. The dried flowers of Gomphrena had acceptability score of 9.20 and 8.67 following vertical and water drying respectively. The water dried (6.72) panicles of Golden Rod had higher acceptability than vertically dried (6.47) whereas peduncles of Golden Rain Tree had higher acceptability for vertical drying (7.80) than water drying (7.64).

Acceptability during 6 months storage

The acceptability of dried plant parts declined with increase in storage duration. The decline was more during initial months of storage and later it stabilized (Table 4). The acceptability of invertedly dried flowers of Gomphrena was 9.33 after 1 month of storage that declined to 8.80 after 4 months and thereafter remains stable. The flowers dried by vertical drying have acceptability of 9.20 after 1 month of storage that continuously declined to 8.33 after 6 months of storge. The corresponding scores for acceptability were 9.00 and 8.00 for water dried flowers. Like Gomphrena dried flowers, the panicles of Golden Rod dried by inverted drying had higher acceptability of 8.20 after 1 month of storage in comparison to 7.20 for vertical drying and 7.56 for water drying (Table 5). After 6 months of storage, the acceptability score declined to 7.40 for inverted drying, 5.73 for vertical drying and 5.43 for water drying. The peduncles of Golden Rain Tree also had higher accepatbilty after storage when dried by inverted method followed by vertical and water drying method. There was gradual decline of acceptability from 8.98 to 8.67 scores during 6 months of storage for peduncles dried invertedly, 8.14 to 7.67 for vertically dried peduncles and 8.02 to 7.33 scores for water dried peduncles (Table 6). The above results indicated that among different methods, the acceptability score of plant parts dried by inverted drying method was highest even after 6 months of storage.

Our results are concomitant with several reports on drying flowers and other plant parts that inverted air drying is one of the easiest methods of preserving plant parts with no expense and best acceptability (Dilta *et al.*, 2014, Dana and Lerner, 2011, Laliberte, 2004). The suitability of different plant parts viz. inflorescences, seed pods, seed heads of grasses and other plants in addition to flowers for inverted air drying has also been confirmed earlier (Collier and Jett, 2002 and Trinklein, 2000).

CONCLUSIONS

Comparison of different methods of drying revealed that inverted air drying was found to be the best method for drying plant parts of different ornamentals. Further, results revealed that the inverted air drying in well ventilated dark room took fewer days for complete drying with highest scores for colour, shape and texture retention and least for shattering. The dried plant parts could be stored for more than 6 months with high acceptability score. The cost effective and easy approach to inverted air drying method will expand the utility of plant parts of locally available ornamentals in different floral products. This will also open doors for unemployed youths, housewives and rural women to develop entrepreneurship in the expanding floriculture industry.

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