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EFFECT OF DRYING TECHNIQUES AND EMBEDDING MEDIA ON DRIED FLOWER QUALITY OF ROSE (*Rosa chinensis* Jacq.) AND WATER LILY (*Nymphaea alba* L.)

Renuka, S. K. Moond, A. Mishra, S. K. Jain[1] and C. K. Arya

Department of Floriculture and Landscaping, College of Horticulture and Forestry, Jhalarapatan, Jhalawar-326023 (Agriculture University, Kota, Raj.)

[1]*Department of Post-harvest Technology, College of Horticulture and Forestry, Jhalarapatan, Jhalawar-326023*
**Corresponding Author's E-mail: ashokchoudhary116@gmail.com*

ABSTRACT : An investigation was conducted to study the effect of drying techniques and embedding media on dried flower quality of rose (*Rosa chinensis* Jacq.) and water lily (*Nymphaea alba* L.) at the College of Horticulture & Forestry, Jhalawar (Raj.), comprising of 22 treatments including three drying conditions *viz.* air drying without embedding (control), hot air oven drying (At 40°C, 50°C and 60°C for 24 hours) and microwave oven drying (2 minutes, 3 minutes and 4 minutes at 350 Hz) in a combination with three different embedding media *viz.* sand, borax and silica gel. The experiment was laid out in completely randomized design (CRD) with three replications. The largest sized dried flowers (5.91 cm in rose and 10.00 cm in water lily) were recorded in microwave oven drying at 350 Hz for 2 minutes plus sand embedding. The maximum weight loss (86.78 % in rose and 88.71 % in water lily) was recorded in Microwave oven drying at 350 Hz for 4 minutes plus silica gel embedding. The minimum pigment loss in dried flowers of rose (20.27 %) was recorded in microwave oven at 350 Hz for 2 minutes plus embedding. The highest sensory scores for colour (8.13 and 7.95), shape (8.57 and 7.87) and overall acceptability (8.23 and 7.90) of dried flowers of rose and water lily, respectively were recorded with silica gel embedded flowers dried in microwave oven at 350 Hz for 3 minutes as against the lowest scores for colour (5.08 and 5.01), shape (5.04 and 4.93) and overall acceptability (5.01 and 4.97) of dried flowers of rose and water lily, respectively recorded with control (air drying without embedding).

Keywords : *Rose, water lily, embedding media, sensory score.*

Commercial floriculture has attracted attention in India due to enormous export potential and increased domestic use of flowers in daily life with the improvement in living standards of people. There is an increasing trend all over the world for the decoration of living and working places with eco-friendly things like fresh flowers and foliages, dried plant parts and dry flowers. Fresh flowers though exquisite in their beauty are highly expensive. Also, they are perishable and delicate in nature and cannot retain their beauty and fresh look for a long time in spite of using chemicals and other compounds for enhancing vase life. Moreover, fresh flowers and foliages are not available round the year in different climatic regions (Datta, 5). The dried flowers are near to natural, having beauty as well as an everlasting value, if preserved with appropriate dehydration technology. Hence, the dried flowers are extra special as they can be kept and cherished for years together (Singhwi, 25). The dry flower industry in India is about fifty years old and today India stands fourth in dry flower exports worldwide (Aruna *et al.,* 1). Potpouri's being the major segment of dry flower industry valuing at Rs. 55 crores in India alone (Nirmala *et al.,* 15). In recent floriculture trade, the export of dry flowers from India during 2013-2014 was Rs. 363.3 crores (Periban *et al.,* 16). Rose is one of the top ranking cut flowers in the international flower trade and the dry cut flowers of roses are the most expensive and exquisite of all dried flowers traded in the international market (Barnett and Moore, 3; Bhalla *et al.,* 4). Similarly, white water lily is a beautiful aquatic plant. It is a very popular plant for cultivation in ornamental ponds. Hence, considering the premium potential of rose and water lily in dry flower industry, the study was planned to find out the most effective drying technique and embedding medium for quality dried flowers of rose and water lily.

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MATERIALS AND METHODS

The open pond cultivated flowers of white water lily and open field produced flowers of rose under Jhalawar conditions were used in the study. The flowers at suitable stages of maturity were harvested in the months of October and November 2015 and put for drying and dehydration as per the treatments. Healthy, disease free and uniform flower were harvested at half bloom stage (Safeena *et al.,* 20) in the morning hours between 8.00 and 9.00 am by cutting with sharp knife. Immediately after harvest, the base of the flower stalks were placed in tap water and brought to the Laboratory, Department of Floriculture and Landscaping, College of Horticulture and Forestry, Jhalarapatan, Jhalawar to give various treatments. The stem length of each flower was kept at a uniform length of 10 cm. The leaves present on each cut stem were removed before using them for drying.

Observations regarding dry flower size, reduction in size of dried flower, reduction in length of petal, reduction in breadth of petal, weight loss, pigment loss during drying. A panel of 9 judges assessed the sensory parameters viz., colour, shape and overall acceptability by scoring on a 9 point scale i.e. liked extremely (9 points), liked very much (8 points), liked moderately (7 points), liked slightly (6 points), neither liked nor disliked (5 points), disliked slightly (4 points), disliked moderately (3 points), disliked very much (2 points), disliked extremely (1 points).

Statistical analysis : The experiment was arranged in completely randomized design (CRD), with 22 treatments each having three replicates. Data were subjected to analysis of variance (ANOVA)using statistical software OPSTAT, CCS HAU, Haryana, India and the critical difference (C.D. P=0.05) was used to compare the means (Gomez and Gomez, 9).

RESULTS AND DISCUSSION

Dry flower size (cm) : It is evident from the (Table 1) that the dry flower size significantly varied for the different treatments. The dry size of the flowers reduced as the drying temperature increased. The largest dry flowers were observed with T_{14} (5.91 cm and 10.00 cm diameter) in rose and water lily respectively as compared to other treatments. The smallest dry flowers were recorded in T_1 (4.51 cm and 7.75 cm diameter) in rose and water lily respectively. The largest dry flower size in microwave oven dehydration in sand could be due to the fact that sand does not react with water vapour released during the process of drying as in the case of silica gel and borax. It allows the water vapour to escape into the air freely thereby causing minimum shrinkage in size of flowers (Sindhuja *et al.,* 23). The results are in line with Rajesh *et al.* (18) in chrysanthemum and Nirmala *et al.* (15) in carnation.

Flower weight loss (%) : The data pertaining to flower weight loss during drying in rose and water lily are presented in (Table 2). The data clearly show that the weight loss varied significantly for the different treatments. The maximum weight loss of flowers was in T_{22} (86.78 % and 88.71 % in rose and water lily, respectively) followed by T_1 86.34 % in rose and 88.10 % in water lily whereas it was minimum in T_{14} (81.98 % in rose and 81.74 % in water lily). The data clearly show that the maximum weight loss in dried flowers of both rose and water lily was in T_{22} (Microwave oven 350 Hz + 4 Minutes + Silica gel). The highest weight loss in microwave oven dehydration in silica gel medium could be due to the fact that microwave treatment agitates the water molecules present in flower petals and silica gel has superior hydro sorbent properties in comparison to other treatments. The hydro sorbent properties of silica gel may be ascribed to the fact the silica gel is manufactured from sodium silicate and is composed of a vast network of inter connecting microscopic pores, which attract and hold moisture by a phenomenon known as physical absorption and capillary condensation (Safeena *et al.,* 20). Pertuit (17) also reported that silica gel can absorb water about 40 per cent of its weight, so it is appropriate for drying flowers with closely packed petals such as rose. The lesser weight loss in sand may be due to the fact that sand has larger particle size and is heavier in weight and thus absorbs less moisture as well as it is not able to retain moisture for longer duration and consequently the moisture is re-absorbed by the flowers (Dilta *et al.,* 7). The present findings also find support from earlier works (Gantait and Mahato, 8; Singh and Dhaduk, 24 and Sindhuja *et al.*, 23).

Table 1 : Effect of drying techniques and media on dried flower quality of Rose and Water lily.

Treatment	Dry flower size (cm)		Flower weight loss (%)	
	Rose	Water lily	Rose	Water lily
T_1	4.51	7.75	86.35	88.10
T_2	5.66	10.04	82.16	82.13
T_3	5.59	9.76	82.36	82.62
T_4	5.59	10.19	82.64	82.96
T_5	6.02	10.81	82.42	82.74
T_6	5.80	9.83	82.71	83.11
T_7	5.92	10.71	83.02	83.45
T_8	6.00	10.66	83.13	83.25
T_9	5.74	10.66	83.32	83.61
T_{10}	5.87	10.07	83.84	84.07
T_{11}	5.94	10.75	83.77	83.77

T_{12}	5.80	10.14	83.94	84.17
T_{13}	5.89	10.48	84.54	84.86
T_{14}	5.91	10.00	81.98	81.74
T_{15}	5.87	10.54	84.70	84.72
T_{16}	5.92	10.28	85.03	85.31
T_{17}	5.98	10.79	84.89	84.86
T_{18}	5.86	10.18	84.94	84.96
T_{19}	5.87	10.70	85.93	86.41
T_{20}	5.96	10.34	85.48	85.30
T_{21}	5.70	10.42	85.74	85.73
T_{22}	5.82	9.93	86.79	88.71
C.D. (P=0.05)	0.102	0.523	1.45	1.52

Table 2 : Effect of drying techniques and embedding media on pigment loss during drying (%) in Rose.

Treatment	Fresh pigment content (mg/g)	Dried pigment content (mg/g)	pigment content in dried flower (mg/g)
T_1	1.55	0.57	63.14
T_2	1.51	1.01	32.74
T_3	1.53	1.08	29.48
T_4	1.57	1.18	24.89
T_5	1.51	0.91	39.73
T_6	1.54	1.96	37.30
T_7	1.52	1.20	20.80
T_8	1.55	0.87	43.87
T_9	1.53	0.93	39.15
T_{10}	1.54	1.03	33.33
T_{11}	1.51	0.81	46.83
T_{12}	1.52	1.90	40.36
T_{13}	1.50	1.01	32.74
T_{14}	1.50	0.94	37.10
T_{15}	1.52	0.99	35.09
T_{16}	1.51	1.21	20.27
T_{17}	1.57	0.89	43.40
T_{18}	1.54	0.96	37.56
T_{19}	1.56	1.20	22.27
T_{20}	1.51	0.84	44.35
T_{21}	1.53	0.93	39.33
T_{22}	1.52	1.07	29.38
C.D. (P = 0.05)	NS	0.034	3.19

Pigment loss during drying (%) : It is evident from Table 3 that the pigment loss during drying varied significantly for different treatments. The pigment loss was maximum in T_1 (63.14 %) and it was minimum in T_{16} (20.27 %). The presented data also show that the pigment loss during drying was the maximum in flowers dried without embedding (control). The more loss of anthocyanin content may be ascribed to fact that there is degradation of anthocyanin and browning effect of anthocyanin at higher temperature. Since anthocyanins are water soluble and located in vacuoles so at higher temperature there is more moisture loss and release of higher amounts of ethylene which might have caused disintegration of tonoplast, thus leading to more degradation of anthocyanin pigments (Dilta *et al.,* 7). Similar results have also been reported by (Minquez *et al.,* 12) and (Sharma *et al.,* 22) in carrots. Better colour retention due to lesser anthocyanin degradation in T_{16} (Microwave oven 350 Hz + 3 Minutes + Silica gel) could be due to lesser heat generation in microwave oven as compared to other drying treatments along with added effect of silica gel embedding on pigment retention of flowers as higher dehydration temperature leads to higher loss of pigments without embedding. Silica exhibited slow heating effect at low temperature particularly for less duration, thereby, resulting in less disintegration of tonoplast as well as release of minimum amount of ethylene from the flower tissues, which might have ultimately resulted in lesser degradation of anthocyanin pigments. The results are in close proximity with the findings of (Smith, 26).

Sensory evaluation : The colour of fresh flowers and its minimum retention during dehydration is an important factor to obtain good aesthetic quality of dried flower. Significant differences were noticed amongst the treatments for colour of dried rose and water lily flowers as presented in Table 3. The highest sensory score for colour was recorded in T_{19} in rose (8.13) and in water lily (7.95), while the least score in T_1 in rose (5.08) and in water lily (5.01). The highest score in microwave oven + silica gel medium could be due to that silica gel prevents the direct removal of moisture from flowers by acting as an intermediate which prevents shrinkage of the flowers and degradation of colouring pigments that could take place when petal tissues are directly exposed to high temperatures and light. The results are in line with those of (Joykumar, 10) flowers of rose; China aster and chrysanthemum in oven drying with silica gel as embedding medium. Better colour retention in silica gel embedding has also been reported by Sandhu (21) in helichrysum and statice, Kumari and Peiris (11) in rose and Singh and Dhaduk (24) in chrysanthemum and rose. The least score for colour retention obtained in air drying embedded may be due to direct exposure of flowers to light and temperatures. The results are in conformity with the finding of Safeena *et al.* (19), Dhatt *et al.* (6) and Sindhuja *et al.* (23).

The sensory scores for shape of dehydrated flowers of rose and water lily have been presented in Table 3. The results show that there were significant differences for shape of dehydrated flowers for different treatments. Amongst the treatments, T_{19} recorded the highest score for flower shape in rose (8.57) and in water lily (7.87), while the least score was recorded in T_1 in rose (5.04) and in water lily (4.93). The results also find supports from the findings of Safeena *et al.* (20) in rose, China aster and chrysanthemum, Aravinda and Jayanthi (2) in chrysanthemum. Least score for shape of dried flowers was noticed with the flowers dried without embedding (control) conforming to reports of Kumari and Peiris (11), Dhatt *et al.* (6), Nirmala *et al.* (14) and Sindhuja *et al.* (23).

The data from Table 3 revealed that the maximum score for overall acceptability was recorded with T_{19} in rose (8.23) and in water lily (7.90) whereas the least score was recorded in T_1 in rose (5.01) and water lily (4.97). Nirmala *et al.* (14) reported that overall acceptability was highest when carnation flowers were embedded in silica gel. Nair and Singh (13) reported that chrysanthemum flowers embedded in silica gel scored the maximum points for good appearance. Least score was recorded in flowers dried without embedding (control). Similar results have also been recorded by Sindhuja *et al.* (23).

Table 3: Effect of drying techniques and embedding media on dried flower quality of Rose and Water lily as assessed through sensory evaluation.

Treatment		Colour	Shape		Overall acceptability	
	Rose	Water lily	Rose	Water lily	Rose	Water lily
T_1	5.08	5.01	5.04	4.93	5.01	4.97
T_2	5.31	5.20	5.27	5.59	5.30	5.15
T_3	5.90	5.71	5.87	5.12	5.86	5.66
T_4	7.18	7.01	7.02	6.68	7.12	6.92
T_5	7.09	6.91	7.01	6.86	7.03	6.92
T_6	7.04	7.01	6.81	6.81	6.96	6.85
T_7	7.12	7.02	7.04	6.94	7.10	6.95
T_8	7.39	7.05	7.12	6.96	7.31	6.98
T_9	7.16	7.09	7.02	6.92	7.13	6.95
T_{10}	8.09	7.16	8.21	6.97	8.00	7.03
T_{11}	7.57	7.02	7.35	7.02	7.34	7.06
T_{12}	7.17	7.13	7.05	6.97	7.10	6.98
T_{13}	7.27	7.26	7.02	7.18	7.20	7.21
T_{14}	7.25	7.02	7.05	7.02	7.21	6.92
T_{15}	7.19	7.05	7.02	6.87	7.13	6.95
T_{16}	8.04	7.54	8.00	7.35	8.11	7.42
T_{17}	7.26	7.13	7.04	7.09	7.19	7.08
T_{18}	7.69	7.21	7.09	7.04	7.43	7.16
T_{19}	8.13	7.95	8.57	7.87	8.23	7.90
T_{20}	7.39	7.33	7.09	7.13	7.25	7.29
T_{21}	7.52	7.39	7.21	7.09	7.30	7.22
T_{22}	7.77	7.55	7.35	7.21	7.50	7.41
C.D.(P = 0.05)	0.321	0.136	0.229	0.239	0.149	0.083

From the findings of the experiment it may be conducted that silica gel- microwave combination is the most suitable method of dehydration of rose and water lily with respect of maximum weight loss, minimum pigment loss, colour, shape and overall acceptability.

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