Studies on the effect of drying media, microwave time and setting duration on drying of chincherinchee (*Ornithogalum thyrsoides* Jacq) in microwave oven

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ABSTRACT

The studies on the effect of drying media, microwave time and setting duration on drying of chincherinchee (*Ornithogalum thyrsoides* Jacq) in microwave oven were conducted in the Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during November 2013 to August 2014. Two drying media were used for embedding of flowers in microwave oven drying viz silica gel and sand + silica gel (50:50 v/v). After embedding the flowers were kept for different microwave times (3, 4 and 5 minutes) and for different setting durations (24, 48 and 72 hours) outside the microwave oven. In total there were 18 treatment combinations replicated thrice. The results obtained showed that maximum score for quality parameters were recorded in flowers embedded in silica gel kept for 3 minutes and for 24 hours setting duration (18.60/20) and minimum score (10.13/20) was obtained when the flowers were dried in sand + silica gel kept for 5 minutes and for 72 hours. Maximum moisture loss (84.77%) was recorded in flowers kept for 5 minutes and for 72 hours setting duration and minimum (63.65%) was recorded in flowers kept for 3 minutes and for 24 hours setting duration. Flowers embedded for longer microwave time and for prolonged setting duration showed maximum moisture loss but quality parameters were declined. Maximum moisture loss as well as maximum score for quality parameters were recorded by the flowers embedded in silica gel as compared to sand + silica gel.

Keywords: Dry flowers; drying; embedding; quality parameters

INTRODUCTION

Flowers have always remained an integral part of mankind and love for flowers is a natural instinct. Dry flowers are rapidly gaining popularity amongst the floriculturists and buyers since they are inexpensive, long-lasting and eco-friendly. The products are available throughout the year. Fresh flowers though exquisite in their beauty are expensive, short-lived and available only during a particular season. On the other hand dried flowers score over cut flowers because they are products near to natural and are extra-special because of their everlasting values and can be cherished for years. The added merit of dried flowers is that they survive the heat of summer and cold of winter (Bhalla et al 2006). In nature the best plant material tends to discolour during drying largely due to oxidative reactions associated with loss of compartmentation within the plant cells during desiccation of the plant tissues (Bhutani 1995). Processing techniques particularly drying techniques assume a great significance in determining the final quality of dry flower products. Dry flower products can be stored for very long periods without any loss in their appearance and decorative value (Ranjan and Misra 2002).

Ornithogalum thyrsoides Jacq (chincherinchee) is a bulbous plant and belongs to family Liliaceae. It is native to South Africa. It produces

white coloured cup-shaped flowers in dense racemes. Flower stalks are leafless and produce either a tight cluster of flowers or few flowers in a loose corymb with flowers reaching almost the same height. Flower stalks remain in presentable condition even after termination of vase life and hence can be used as dry flowers. Drying techniques play an important role in the overall quality of the dried produce. But there is a dearth of literature on the drying aspects of chincherinchee. Hence the present investigations were undertaken to find out most effective embedding medium, microwave time and setting duration for microwave oven drying of it. The principle of microwave drying is based on liberation of moisture by agitating water molecules present in organic substances with the help of electronically produced microwaves. By this method drying is fast and generates less heat (Bhutani 1990).

MATERIAL and METHODS

The present investigations were conducted in the Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during November 2013 to August 2014. The bulbs of *Ornithogalum thyrsoides* Jacq were planted in the field in November 2013 under naturally-ventilated polyhouse at the experimental farm of the Department. Standard cultural practices were followed throughout the cropping period till flowering. The flowers were harvested in the months of March and April. Healthy, disease-free and uniform flower stems were harvested when 10-11 florets were open. Flowers were harvested in the morning and immediately after harvesting they were put in water. They were then brought to the laboratory to give various treatments. The stem length of each cut flower selected for experiment was kept 18 cm. Glass jars (20 cm height and 5.5 cm diameter) selected for drying were filled evenly with two different drying media viz M_1 (silica gel) and M_2 (sand + silica gel 50:50 v/v) up to 5 cm of height. After putting the flowers into the containers the media were poured gently for uniform covering of the florets and filled up to the rim. Drying media were evenly distributed so as to equalize the pressure on all sides of the flower. After this the containers were kept inside the microwave oven for specified durations (microwave time) viz T_1 (3 min), T_2 (4 min) and T_3 (5 min). The glass jars were removed after the treatment from the microwave and were kept as such for different durations (setting durations) viz D_1 (24 hours), D_2 (48 hours) and D_3 (72 hours). After drying the embedded flowers were taken out carefully by tilting the containers. The flowers were rolled down and were collected. They were tapped by holding them from stem to remove the excess drying medium. Florets were also gently brushed with soft camel hair brush to remove the drying media completely so that the original colour of the dried flower could be seen. There were 18 treatment combinations replicated thrice. The data were collected on fresh weight and dry weight of flowers, per cent moisture loss, flower colour and quality parameters/sensory scores (flower colour, texture, brittleness and shape retention). The data obtained thus were subjected to statistical analysis of variance using CRD (factorial).

RESULTS and DISCUSSION

Data on the effect of different treatments on moisture loss and quality of flowers of *Ornithogalum thyrsoides* dried in microwave oven are presented in Table 1.

Moisture loss: Chincherinchee cut flowers dried in silica gel (M_1) showed more moisture loss (81.54%) as compared to flowers dried by embedding in sand:silica gel (50:50 v/v) (69.55%). This might be due to the strong hygroscopic nature of silica gel which led to the rapid removal of moisture from the flowers. These results are in concordance with dehydration of zinnia flowers by Singh et al (2003) who also reported that maximum moisture loss was when flowers were embedded in silica gel as compared to sand and borax. Moona (2004) while working on chrysanthemum cv Nanako also reported maximum moisture loss in flowers embedded in silica gel when dried in microwave oven (82.38%) as compared to river sand + silica gel. The better hydrosorbent properties of silica gel may be ascribed to the fact that 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 and Patil 2013). On the contrary the less moisture loss in river sand may be due to the fact that sand has a 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. Consequently the moisture is reabsorbed by the flowers.

Maximum moisture loss (82.73 %) was recorded at 5 minutes (T_3) and minimum (67.15%) at 3 minutes (T_1) microwave time. Drying of flowers for

Table 1. Effect of drying media (M), microwave time (T), setting duration (D) and their interaction on moisture loss and quality parameters of flowers of *Ornithogalum thyrsoides* Jacq dried in microwave oven

	D_1				D_2				D_3				M x T			M
	T_1	T_2	T_3	M x D	T_1	T_2	T_3	M x D	T_1	T_2	T_3	M x D	T_1	T_2	T_3	
Moisture loss (%)																
M_1	72.19	80.32	85.99	79.50	75.63	82.16	86.27	81.35	78.43	84.57	88.25	83.75	75.42	82.35	86.37	81.54
M_2	55.10	64.09	76.66	65.28	58.54	73.85	77.96	70.11	63.02	75.47	81.29	73.26	58.89	71.14	78.63	69.55
T x D	63.65	72.21	81.32	72.39	67.09	78.00	82.11	75.35	70.73	80.02	84.77	78.50	67.15	76.74	82.73	
Quality parameters (scoring out of 20)																
M_1	18.60	18.27	15.80	17.56	18.43	16.80	17.60	17.61	18.33	16.20	17.53	17.36	18.46	17.09	16.98	17.51
M_2	14.23	14.20	11.60	13.34	14.00	16.40	11.40	13.93	15.63	15.60	10.13	13.79	14.62	15.40	11.40	13.69
T x D	16.42	16.23	13.70	15.45	16.22	16.60	14.50	15.77	16.98	15.90	13.83	15.57	16.54	16.24	14.01	

M_1= Silica gel, M_2= Sand:silica gel (50:50 v/v), T_1= 3 minutes, T_2= 4 minutes, T_3= 5 minutes, D_1= 24 h, D_2= 48 h, D_3= 72 h

$CD_{0.05}$

	M	T	D	M x T	M x D	T x D	M x T x D
Moisture loss	1.12	1.38	1.38	1.95	1.95	2.38	NS
Quality parameters	0.21	0.25	0.25	0.36	0.36	0.44	0.62

setting duration of 72 hours (D_3) resulted in maximum moisture loss (78.50%) whereas minimum (72.39%) was observed in flowers dried for 24 hours (D_1). It might be owing to higher temperature for maximum duration which caused the maximum drying in flowers. In addition liberation of more moisture content at high temperature could be due to the fact that there was high circulation of electric waves generated at high temperature.

In case of interactions drying media × microwave time revealed that maximum moisture loss (86.37%) was recorded when flowers were embedded in silica gel and kept at 5 minutes in microwave (M_1T_3) whereas minimum (58.89%) was recorded in flowers dried by embedding in sand:silica gel (50:50 v/v) kept at 3 minutes in the microwave (M_2T_1). The interaction drying media × setting duration elucidated that maximum moisture loss (83.75%) was recorded in flowers embedded in silica gel kept for 72 hours setting duration (M_1D_3) whereas minimum moisture loss (65.28%) was recorded in flowers embedded in sand:silica gel (50:50 v/v) kept for 24 hours setting duration (M_2D_1). The maximum loss of moisture content in silica gel may be due to its better hygroscopic nature which was further catalyzed when kept as such for longer duration outside microwave oven where further absorption of moisture from flower tissues continued for longer duration. The interaction microwave time × setting duration showed that maximum moisture loss (84.77%) was recorded in flowers kept at 5 minutes in microwave for 72 hours setting duration (T_3D_3) whereas minimum (63.65%) was recorded in flowers kept at 3 minutes in microwave for 24 hours setting duration (T_1D_1). The interaction drying media × microwave time × setting duration was found to be non-significant.

Flower colour: Colour of the microwave oven-dried flowers was recorded as per the colour chart of Royal Horticulture Society (RHS), London. The colour of fresh flowers fell in White Group (155 C) of RHS colour chart. The observations recorded by the RHS colour chart revealed that flowers which were dried by embedding in silica gel in microwave oven were more close to natural flower colour (155C Group). The colour was more towards yellow groups and was greyer when the flowers were dried by embedding in sand + silica gel. These results are in concordance with Katoch et al (2010) who studied the drying effect of different drying methods for *Acroclinum* flowers. In case of colour highest score was recorded in microwave drying when embedded in silica gel.

Quality parameters: Microwave oven dried flowers were evaluated for quality parameters based on colour, texture, brittleness and shape retention. Each parameter was allotted 5 points and hence the flowers were scored out of a total of 20 modified after Peryam (1957) and Visalakshi (2013).

Chincherinchee flowers dried in silica gel (M_1) obtained higher score (17.51) for quality parameters after drying in microwave oven whereas lower score (13.69) was obtained by flowers dried in sand:silica gel (50:50 v/v) (M_2). Safeena and Patil (2013) reported that embedding the flowers in silica gel prevents the direct removal of moisture from flowers and acts as an intermediate and consequently prevents the shrinkage of the flower and degradation of colouring pigments that could take place when petal tissues are exposed to higher temperatures without embedding. Similar results have been obtained in the present study too. But shedding of florets was found to be more in silica gel-embedded flowers which might be due to the strong hygroscopic nature of silica granules which makes the flower more brittle with maximum moisture removal. This is also in accordance with the findings of Nirmala et al (2012) in case of carnation cv Master where maximum petal loss was noticed with silica gel in comparison to quartz sand. Therefore all the treatments which contained sand scored lower for quality parameters.

While comparing microwave time highest score (16.54) was obtained when the flowers were dried for 3 minutes (T_1) in microwave oven whereas least score (14.01) was obtained by the flowers which were dried for 5 minutes (T_3). These results are in concordance with the results obtained by Biswas and Dhua (2010) who found that flowers of two standard carnation varieties viz Kristina and Cano when subjected to drying treatments in microwave oven (1200 watt) after embedding them in desiccant silica gel (60-120 mesh) for 2 to 4 minutes gave best result in carnation at shortest duration of microwave oven drying for a period of two minutes.

In setting duration flowers kept for 48 hours (D_2) obtained highest score (15.77) which was found to be statistically at par with the flowers kept for 72 hours (D_3) whereas lowest score (15.45) was obtained

$M_1 T_1 D_1$

$M_1 T_3 D_3$

$M_1 T_2 D_1$

$M_1 T_1 D_2$

$M_1 T_2 D_3$

$M_2 T_2 D_1$

M_1= Silica gel, M_2= Sand:silica gel (50:50 v/v), T_1= 3 minutes, T_2= 4 minutes, T_3= 5 minutes, D_1= 24 h, D_2= 48 h, D_3= 72 h

Plate 1. Effect of drying media (M), microwave time (T) and setting duration (D) on quality parameters of flowers of *Ornithogalum thyrsoides* Jacq dried in microwave oven

when the flowers were kept for 24 hours (D_1). Drying of flowers for prolonged durations caused maximum shedding of florets of chincherinchee which could be attributed to excessive loss in moisture that resulted into weakened adhesion and cohesion forces in flower tissue causing softening of middle lamella leading to abscission. These results are in agreement with the observations of Singh et al (2003) on drying of zinnia where moisture below 8 per cent showed shedding effect.

In case of interactions drying media × microwave time revealed that highest score (18.46) was obtained when the flowers were dried by embedding in silica gel and kept at 3 minutes in microwave (M_1T_1) whereas least score (11.40) was obtained when the flowers were dried by embedding in sand:silica gel (50:50 v/v) kept at 5 minutes in microwave (M_2T_3). The interaction drying media × setting duration showed that highest score (17.61) was obtained when the flowers were embedded in silica gel kept for 48 hours (M_1D_2) and lowest score (13.34) was obtained when the flowers were dried in sand:silica gel (50:50 v/v) kept for 24 hours (M_2D_1). The interaction microwave time × setting duration elucidated that highest score (16.98) was obtained when the flowers were dried at 3 minutes in microwave kept for 72 hours setting duration (T_1D_3) whereas least score (13.70) was obtained when the flowers were dried at 5 minutes in microwave kept for 24 hours setting duration (T_3D_1). The interaction drying media × microwave time × setting duration revealed that the highest score for quality parameters (18.60) was obtained when the flowers were dried in silica gel, kept at 3 minutes in microwave for 24 hours setting duration ($M_1T_1D_1$) whereas least score (10.13) was obtained when the flowers were dried in sand:silica gel (50:50 v/v) kept at 5 minutes for 72 hours ($M_2T_3D_3$).

CONCLUSION

Maximum moisture loss (84.77%) in case of microwave oven-dried flowers was recorded in *Ornithogalum thyrsoides* flowers kept for 5 minutes microwave time for 72 hours setting duration. However in terms of quality parameters maximum score (18.60) out of a total of 20 was allotted to flowers embedded in silica gel dried at 50°C for 24 hours duration. Flowers embedded for longer microwave time and for prolonged setting duration showed maximum moisture loss but quality parameters declined which is not desirable aesthetically. Maximum moisture loss as well as maximum score for quality parameters were recorded by the flowers embedded in silica gel as compared to other drying media used.

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