

Studies on the Effect of Microwave Oven Drying on Flower Quality of Dried Dutch Rose Flowers

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Abstract The present study was conducted to investigate the effect of micro wave oven drying on dry flower quality of four cultivars of Dutch rose flowers viz., Skyline, Lambada, Ravel and First Red. The experiment was laid out in three factorial completely randomized design. Quality parameters such as colour (3.48), appearance (3.51) and texture (3.29) were superior in flowers dried for 2.5 min by embedding in silica gel, while unacceptable quality was obtained in case of flowers dried without any embedding medium. With respect to mode of desiccation, embedded drying was best for quality parameters viz., colour (2.92), appearance (2.81) and texture (2.55); however, non-embedding methods were least acceptable for quality parameters. The results of the present study also suggest that flowers of cv. 'Lambada' dried by embedding in silica gel would yield best quality dried flowers as it scored maximum point for all the quality parameters studied. Also, it is evidenced from the present study that flowers of cv. 'Lambada' dried for 2.5 min was best for quality parameters, viz., colour (2.53), appearance (2.56) and texture (2.41).

Keywords Rose · Dehydration · Microwave oven · Silica gel

Introduction

Rose is one of the nature's most beautiful creations and is universally extolled as the "Queen of Flowers". Rose is the top ranking cut flower in the flower trade on the basis of average production and consumption. Rose flowers are diverse having exquisite shape, size, and beautiful colours. There is a non-availability of fresh flowers of roses all round the year in all places [1]. In this context rose flowers can be dried, preserved and processed to retain its beauty as well as everlasting value. The use of dried flowers has made it possible to enjoy their beauty for several years. The beauty and value of the dried flowers are that they can be kept and cherished for years, which survive the cold of winter and heat of summer [2]. Dried and preserved ornamental products offer a wide range of qualities like novelty, longevity, aesthetic properties, flexibility and year round availability [3]. With growing eco-consciousness, the use of more and more nature-friendly things has become a natural choice for decoration. Future prospects of the dry flower industry are expected to contribute a lot to the country's economy in comparison to the fresh cut flowers and other live plants [4]. Considering the potential of Dutch roses in dry flower trade, an attempt was made in the present investigation to determine the best mode of desiccation, best cultivar and best time level for drying rose flowers in electrically operated micro wave oven.

Materials and Methods

The present study was carried out in the laboratory of Department of Horticulture, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka during 2005. Four cultivars of Dutch roses used for the

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present study include Yellow variety 'Skyline', Orange variety 'Lambada', Pink variety 'Ravel' and Red variety 'First Red'. All the 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 [5]. The flowers of all the four Dutch rose cultivars were dehydrated in electrically operated microwave oven at three different time levels (3.0, 2.5 and 2.0 min) by with and without embedding in silica gel. Half opened flowers of all the four cultivars were embedded in silica gel in glasswares and kept in IFB microwave oven and another set was kept in microwave oven without embedding. Water was placed in a glass container at the back of microwave oven during the operation as suggested by the manufacturers. After drying, the flowers were left undisturbed in the container along with or without desiccant for 3 h (called setting time) to eliminate the moisture. The experimental design followed was completely randomized design with factorial concept. Treatments were replicated three times. Observations on initial fresh weight of the flowers, weight of the flowers after drying, moisture loss percentage and time taken for drying were recorded. Quality parameters like colour, appearance and texture were assessed by means of sensory evaluation by scoring on a five-point scale i.e. excellent, very good, good, bad and very bad with the weightage of 3.5–4.0, 2.5–3.4, 1.5–2.4, 0.5–1.4 and 0.0–0.4 respectively. Experimental data was analysed statistically using MSTAT computer programme. The limit of probability fixed for the level of significance was $P = 0.01$.

Results and Discussion

The principle behind the microwave oven drying is liberating moisture by agitating water molecules in the organic substances with the help of electronically produced microwaves. Drying is exceptionally fast and gets completed within a few minutes and generates little heat [6]. The data pertaining to various parameters, viz., dry weight, moisture loss, colour, appearance and texture of the rose flowers dried in microwave oven as influenced by different time levels and mode of desiccation are presented in Table 1. Dry weight and moisture loss did not show significant differences either due to different time levels or due to embedding (mode of desiccation) and also due to their interactions, which indicated uniform removal of moisture from the flowers. Significant differences were observed due to mode of desiccation for the colour, appearance and texture of dried Dutch rose flowers. Among the mode of desiccation, embedding method scored higher points (2.92) for colour as compared to drying without embedding which scored only 1.19 points. Embedded

flowers scored higher points (2.81) after drying as compared to flowers dried without embedding which scored 1.18 points for appearance. Embedded method was found to retain better texture by scoring 2.55 points. The flowers dried without embedding scored only 1.12 points thereby indicating the poor texture in these dried flowers. Between embedding and non-embedding methods, the flowers desiccated without embedding were poor in quality due to direct exposure to microwaves which might have caused tissue damages and charring effects, further leading to petal fall and degradation of anthocyanin pigments. On the other hand, silica gel pre treatment protected the flowers from such damages. For delicate flowers like roses, dahlia, carnation etc., silica gel is the ideal drying agent [7]. Desiccant method is the useful method for delicate flowers that may fall apart when air dried as opined by Thomler [8]. Significant differences were seen for colour, overall appearance and texture of dried Dutch rose flowers due to different time levels, in which power output level for 2.5 min scored the highest points (2.42) for colour. The flowers dried for 3 min scored the least by recording 1.67 points for colour. The flowers dried for 2.5 min could retain good appearance by scoring maximum points of 2.39. On the other hand, the flowers dried for 3 min scored only 1.63 points thereby indicating failure to retain the original appearance after drying. It was observed that drying for 2.5 min scored higher points (2.29) for retention of texture of dried flowers as compared to other time levels, while the flowers dried for 3 min scored least points (1.29). Among different time levels, subjecting the flowers to power output level for 2.5 min was found to be the best for drying of Dutch roses. Treating the flowers at this power output level was best with respect to quality attributes. Upon subjecting to longer duration of drying, the texture and colour retainment was poor. Increase in the temperature might have been the cause for poor colour. Interactions among different time levels and mode of desiccation were highly significant for colour, appearance and texture of dried rose flowers. Among the interaction effects, embedding the flowers in silica gel and drying for 2.5 min were proved to be the best. Flowers embedded in silica gel and dried at power output level for 2.5 min scored the higher points (3.48), while those dried for 3 min without embedding scored minimum points (1.07) for the colour of dried flowers. Out of all the interaction effects, embedding in silica gel and drying for 2.5 min scored the highest points of 3.51 for retention of appearance, while those flowers dried for 3 min without embedding scored only 1.08 points for the same. Embedded drying in silica gel for 2.5 min was found best for retention of texture scoring 3.29 points, while those flowers dried without embedding for 3 min scored only 0.98 points, which indicated poor retention of texture in these flowers. Acceptability for quality attributes

Table 1 Dry weight, moisture loss, colour, appearance and texture of Dutch rose flowers as influenced by different time levels and mode of desiccation under microwave oven drying

S. No.	Treatments	Dry weight (g/flower)	Moisture loss (%)	Colour	Appearance	Texture
Mode of desiccation (E)						
1.	Embedding in silica gel	3.22	65.74	2.92	2.81	2.55
2.	Without embedding	3.27	65.42	1.19	1.18	1.12
	S.Em±	0.026	0.191	0.005	0.004	0.004
	C.D. at 1 %	NS	NS	0.019	0.016	0.015
Time level (M)						
1.	3.0 min	3.26	65.37	1.67	1.63	1.29
2.	2.5 min	3.23	65.74	2.42	2.39	2.29
3.	2.0 min	3.24	65.63	2.07	1.96	1.94
	S.Em±	0.032	0.234	0.006	0.005	0.005
	C.D. at 1 %	NS	NS	0.023	0.019	0.018
Interaction effect (E × M)						
1.	Embedded drying in silica gel for 3.0 min	3.24	65.47	2.28	2.19	1.60
2.	Embedded drying in silica gel for 2.5 min	3.22	65.81	3.48	3.51	3.29
3.	Embedded drying in silica gel for 2.0 min	3.20	65.96	3.01	2.74	2.77
4.	Without embedding and drying for 3.0 min	3.28	65.28	1.07	1.08	0.98
5.	Without embedding and drying for 2.5 min	3.23	65.67	1.35	1.28	1.29
6.	Without embedding and drying for 2.0 min	3.29	65.30	1.16	1.18	1.10
	S.Em±	0.045	0.331	0.009	0.007	0.007
	C.D. at 1 %	NS	NS	0.033	0.027	0.026

NS non-significant

was low when the flowers were directly exposed for drying without embedding and also drying in desiccant for longer duration. Probable reason is that on direct exposure to microwaves, there will be tissue damages and charring effects further leading to petal fall. Drying is unbelievably fast in microwave oven, when flowers and foliage are embedded in fine silica gel contained in non-metallic earthenware or glassware [9].

Influence of mode of desiccation and cultivars on dry weight, moisture loss and various quality attributes of microwave oven dried rose flowers as assessed through sensory evaluation are represented in Table 2. Dry weight and moisture loss as influenced by mode of desiccation and cultivars did not differ significantly. Score given by the panel members for colour, appearance and texture of the dried flower during sensory evaluation of Dutch rose cvs. Skyline, Lambada, Ravel and First red is depicted in Table 2. All the floral characteristics like colour, appearance and texture were best in the orange coloured cv. 'Lambada' followed by yellow coloured cv. 'Skyline'. The retention of colour of dried Dutch rose flowers was significant with respect to cultivars. Among the four different cultivars evaluated, dry flowers of 'Lambada' scored maximum points (2.20) with respect to retention of colour, whereas least score of 1.92 points was recorded in 'Ravel'. Maximum score (2.16) for appearance was

received by 'Lambada' among the four cultivars while least score of 1.81 points was recorded in 'Ravel'. Significant differences were noticed with respect to flower texture due to different cultivars. Among the four cultivars, maximum score (1.97) was received by 'Lambada'. Least rating of 1.67 points for texture was received by 'Ravel'. Mode of desiccation showed significant difference with respect to colour, appearance and texture of dry flower, in which flowers dried by embedding mode scored the maximum rating of 2.92 for retention of colour, while flowers dried without embedding scored minimum points (1.19). Flowers dried by embedding in powdered silica gel scored maximum points of 2.81 for appearance whereas, flowers dried without embedding scored least points (1.18). The Dutch rose flowers dried by embedding in silica gel scored higher points (2.55) for texture as compared to those which were dried without embedding (1.12 points.) Microwave drying with silica gel gave the best results for shape for chrysanthemum (Button type local) flowers among different techniques tried viz., microwave drying, oven drying and sun drying [10]. Interaction effect of cultivars and different mode of desiccation showed significant difference on colour, appearance and texture of dried Dutch rose flowers. Flowers of 'Lambada' dried by embedding in silica gel scored the maximum rating of 3.07 points for colour, while least score (1.07) was

Table 2 Influence of mode of desiccation and cultivars on dry weight, moisture loss, colour, appearance and texture of Dutch rose flowers under microwave oven drying

S. No.	Treatments	Dry weight (g/flower)	Moisture loss (%)	Colour	Appearance	Texture
Mode of desiccation (E)						
1.	Embedding in silica gel	3.22	65.74	2.92	2.81	2.55
2.	Without embedding	3.27	65.42	1.19	1.18	1.12
	S.Em±	0.026	0.191	0.005	0.004	0.004
	C.D. at 1 %	NS	NS	0.019	0.016	0.015
Cultivars (V)						
1.	Skyline	3.23	65.71	2.10	2.04	1.89
2.	Lambada	3.22	65.79	2.20	2.16	1.97
3.	Ravel	3.26	65.47	1.92	1.81	1.67
4.	First Red	3.28	65.35	2.01	1.97	1.82
	S.Em±	0.037	0.271	0.007	0.006	0.006
	C.D. at 1 %	NS	NS	0.027	0.022	0.021
Interaction effect (E x V)						
1.	Embedding in silica gel × Skyline	3.23	65.76	2.97	2.86	2.61
2.	Embedding in silica gel × Lambada	3.20	65.68	3.07	2.96	2.71
3.	Embedding in silica gel × Ravel	3.23	65.73	2.77	2.66	2.39
4.	Embedding in silica gel × First red	3.22	65.80	2.87	2.76	2.50
5.	Without embedding × Skyline	3.22	65.66	1.22	1.21	1.18
6.	Without embedding × Lambada	3.25	65.90	1.32	1.36	1.23
7.	Without embedding × Ravel	3.28	65.21	1.07	0.96	0.96
8.	Without embedding × First red	3.33	64.90	1.15	1.18	1.14
	S.Em±	0.052	0.383	0.010	0.008	0.008
	C.D. at 1 %	NS	NS	0.038	0.031	0.030

NS non-significant

observed in flowers of 'Ravel' dried without embedding. Flowers of 'Lambada' dried by embedding in silica gel scored the maximum rating of 2.96 points for appearance, while least score (0.96) was observed in flowers of 'Ravel' dried without embedding. Maximum score (2.71) was recorded by the flowers of 'Lambada' which were dried by embedding in silica gel for retention of texture. 'Ravel' dried without embedding scored only 0.96 points for texture. Better appearance, texture and colour was retained in the cv. 'Lambada' owing to its characteristic feature. All the cultivars desiccated by embedding in silica gel scored higher points than those dried without any desiccant for all the quality parameters. Quick action of silica gel for dehydration coupled with its smooth texture and light weight might have better supported the petal arrangement and prevented loss of pigments. Embedded drying retains good colour and form. The phenomenon of embedded drying is that during desiccation, the water content of the flower is completely absorbed by the surrounding desiccant material. Silica gel in powder form is the quickest acting desiccant. Bhutani [11] reported that embedding in silica gel was perhaps the easiest and the best method of embedded drying of flowers.

The data pertaining to dry weight, moisture loss and various quality attributes of dried Dutch rose flowers as influenced by different time levels and cultivars are furnished in Table 3. There was no significant difference in dry weight and moisture loss as influenced by cultivars and different time levels. Among the four cultivars, maximum rating of 2.20 points for colour was received by 'Lambada'. Least score (1.92) for flower colour was recorded in 'Ravel'. The data pertaining to appearance of dried Dutch rose flowers revealed that maximum score of 2.16 points was received by 'Lambada'. Least score (1.81) for appearance was recorded in 'Ravel'. Significant difference was observed in dry flower texture due to different cultivars. The flowers of 'Lambada' received the maximum score of 1.97 for flower texture, while the least score was recorded in flowers of 'Ravel' which scored only 1.67 points. Datta [12] observed microwave oven drying was the most suitable method to dehydrate the white flowers of 'Jubilee' cultivar of chrysanthemum. Significant differences were noticed due to different time levels in microwave oven in which highest score for flower colour (2.42) was recorded in flowers dried for 2.5 min, while the least score (1.67) was recorded in flowers dried for 3 min.

Table 3 Different parameters of Dutch rose flowers as influenced by cultivars and different time levels under microwave oven drying

S. No.	Treatments	Dry weight (g/flower)	Moisture loss (%)	Colour	Appearance	Texture
Cultivars (V)						
1.	Skyline	3.23	65.71	2.10	2.04	1.89
2.	Lambada	3.22	65.79	2.20	2.16	1.97
3.	Ravel	3.26	65.47	1.92	1.81	1.67
4.	First red	3.28	65.35	2.01	1.97	1.82
	S.Em±	0.037	0.271	0.007	0.006	0.005
	C.D. at 1 %	NS	NS	0.027	0.022	0.021
Time level (M)						
1.	3.0 min	3.26	65.37	1.67	1.63	1.29
2.	2.5 min	3.23	65.74	2.42	2.39	2.29
3.	2.0 min	3.24	65.63	2.08	1.96	1.94
	S.Em±	0.032	0.234	0.006	0.005	0.005
	C.D. at 1 %	NS	NS	0.023	0.019	0.018
Interaction effect (V × M)						
1.	Skyline dried for 3.0 min	3.20	65.94	1.69	1.65	1.33
2.	Skyline dried for 2.5 min	3.26	65.65	2.48	2.45	2.39
3.	Skyline dried for 2.0 min	3.22	65.54	2.12	2.02	1.97
4.	Lambada dried for 3.0 min	3.23	65.57	1.77	1.76	1.39
5.	Lambada dried for 2.5 min	3.22	66.23	2.53	2.56	2.41
6.	Lambada dried for 2.0 min	3.22	65.57	2.29	2.17	2.11
7.	Ravel dried for 3.0 min	3.24	65.12	1.57	1.53	1.19
8.	Ravel dried for 2.5 min	3.21	65.76	2.26	2.16	2.06
9.	Ravel dried for 2.0 min	3.31	65.53	1.94	1.75	1.77
10.	First red dried for 3.0 min	3.38	64.86	1.66	1.61	1.27
11.	First red dried for 2.5 min	3.23	65.32	2.40	2.41	2.30
12.	First red dried for 2.0 min	3.22	65.88	1.97	1.90	1.90
	S.Em±	0.064	0.469	0.012	0.010	0.010
	C.D. at 1 %	NS	NS	0.046	0.039	0.036

NS non-significant

Highest score for appearance (2.39) was recorded in flowers dried for 2.5 min; while the least score (1.63) was recorded in flowers dried for 3 min. It was observed that drying for a period of 2.5 min in microwave oven scored maximum rating of 2.29 for flower texture, while the flowers dried for 3 min, scored only 1.29 points. Interaction between cultivars and different time levels in microwave oven for quality parameters was found to be significant. Acceptability was high for flowers of cv. 'Lambada' dried for 2.5 min in the microwave oven. The flowers of 'Lambada' dried for 2.5 min recorded the maximum score of 2.53 points with respect to flower colour while the least score of 1.57 points was recorded in 'Ravel' dried for 3 min. The flowers of 'Lambada' dried for 2.5 min recorded the maximum score of 2.56 points with respect to appearance while the least score of 1.53 points was recorded in 'Ravel' dried for 3 min. Flowers of 'Lambada' dried for 2.5 min scored maximum rating of

2.41 points for flower texture whereas flowers of 'Ravel' dried for 3 min scored the least rating of 1.19 points. Gordon [13] opined that colours that came out close to the original when dried in silica are white, orange, yellow, lavender and blue (non-roses). Darker colours such as red tend to turn out even darker. So the result is in harmony with the aforesaid reports.

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