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Standardization of Drying Techniques of Rose, Carnation, Gerbera and Value-Added Products

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The present experiment was carried out to standardize drying methods for Rose (*Rosa* L.), Carnations (*Dianthus caryophyllus* L.), and Gerbera (*Gerbera* L.), and to assess the influence of the drying quality of the dried flowers to make various value-added products. Flowers of Rose, Carnation, and Gerbera Aster were subjected to five different drying methods viz., shade drying method without embedding medium (T1), with sand embedding (T2) and with silica gel embedding (T3), microwave oven drying with sand (T4) and silica gel embedding (T5). Data were statistically analyzed in Completely Randomized Design. The results indicated that in physiological parameters significantly maximum reduction of weight was observed in Rose (1.14g), Carnation (3.44g), and Gerbera (3.44g). Whereas significantly maximum flower perimeter reduction in Rose (11.14cm), Carnation (11.64cm), and Gerbera (18.17cm) was observed in the shade drying method. Maximum quality score regarding color, appearance, texture, and no shattering of dried flowers of Carnation (15.7) was recorded in microwave oven drying with silica gel as embedding medium, in Rose's highest score (15.7) was observed in microwave oven with sand as embedding medium and in Gerbera (15.51) was given to microwave oven drying within silica gel embedding treatment while shade dried without embedded flowers showed minimum quality score in Rose, Carnation, and Gerbera (3.6, 1.5, 2.52) respectively. Best results were obtained with overall acceptability, quality of flowers, and flower preservation in Rose –treatment T3 (shade drying with silica gel as embedding medium), Carnation- treatment T5 (microwave oven drying with silica gel as embedding medium), Gerbera T4 (microwave oven drying with river sand as embedding medium).

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1. INTRODUCTION

Flowers have always fascinated and dazzled man by being an object of beauty and splendor. Blooms are now rapidly emerging as a money-spinning commodity in global trade. A fresh flower is one of the main components of the floriculture trade. Floriculture has become a profitable industry in many parts of the globe. Flowers are an integral part of mankind and on almost every occasion, from welcoming to the funeral, weddings and various ceremonies have involvement of flowers. Fresh flowers though exquisite in their beauty can be quite expensive and are perishable and most flowers are available only for particular seasons. These reasons have led to the popularity of dry flowers among the masses where people want to enjoy blooms all year long as dried flowers are enduring, add-on aesthetics and are available all year round, irrespective of the season [1]. The dehydrated or dried ornamental plant parts are generally inexpensive and are sought for their everlasting and attractive appearance [2]. The art of flower drying is a very age-old practice. Earlier dried flowers were used in the form of herbarium by botanists for the identification of various species [3]. Though the drying of flowers is well known even in the past for the first time the flowers were dried commercially in Germany [4].

The dry flower industry has become the most promising area in floriculture in the past four decades after it was initially introduced by the British in Calcutta due to its proximity to North-East and eastern regions where exotic and various plants were easily accessible [5]. This industry includes the use of flowers and every part of the plant that can be dehydrated foliage, seeds, flower, stems, etc. The Government of India has identified floriculture as a sunrise industry and accorded it 100 % export-oriented status. The country has exported 15,695.31 MT of floriculture products to the world for the worth of Rs. 575.98 Crores/77.84 USD Millions in 2020-2021. The export market of flowers in India is composed of 71% of dry flowers exported mainly to the U.S.A, Japan, Australia, Europe, and Russia [6]. The demand for dry flowers increases at an impressive rate of 8 – 10%. This industry shows a growth rate of 15% annually. India is the fifth largest exporter of dry flowers in the world.

Rose (*Rosa* L., Rosaceae), Carnation or Clove pink (*Dianthus caryophyllus* L., Caryophyllaceae), and Gerbera or Transvaal daisy (Gerbera L., Asteraceae), are widely grown in India. A rose is a woody perennial flowering plant.. They have a wide range of colors and shapes and are very popular among Indian gardens. Carnation and Gerbera make excellent cut flowers and are widely cultivated in parts of India. Carnation is a herbaceous perennial plant growing up to 80 cm tall. They are widely used in wedding decorations and bouquets. Gerbera is mainly used in flower beds as a decorative cut flower. These daisy flowers are available in all colours but blue. Though dried flowers are earning better exchange than cut flowers, several flowers and ornamentals have not been exploited to produce dry horticultural products among Rose, Carnation, and Gerbera are included [7]. There is the need to identify, explore and evaluate native plant species and various ornamentals having potential as dry flowers as guided by Kawasaki M. [8]. This work aimed to standardize drying methods of Rose, Carnation, and Gerbera and to evaluate the economics of value-added products of dried flowers of Rose, Carnation, and Gerbera [9].

2. MATERIALS AND METHODS

The present investigation was carried out in the laboratory of the Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (UP), during 2021- 2022. For the experiment, healthy, disease-free, and uniform flowers of Rose (*Rosa* L., Rosaceae), Carnation or Clove pink (*Dianthus caryophyllus* L., Caryophyllaceae), and Gerbera or Transvaal daisy (Gerbera L., Asteraceae) were harvested in the morning hours right after evaporation of dewdrops from the plant surface and subjected to five different drying treatments viz., shade drying method without embedding medium (T1), with sand embedding (T2) and with silica gel embedding (T3), microwave oven drying at with sand (T4) and silica gel embedding (T5). Observations such as reduction in weight, percent moisture loss, time taken to dry, percent reduction in perimeter, and percent retention of the perimeter was recorded. After drying, quality parameters such as color, appearance, texture, and shattering of petals were assessed using sensory evaluation by a panel of ten semi-trained judges 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.

In the shade drying method, freshly harvested flowers were tied in bunches and hung vertically in upside down position in shade in the laboratory. For embedding, powdered silica gel of 120 mesh with a blue color indicator and river sand was used . For embedded drying in shade, plastic trays of 10 cm depth were used whereas oven-safe aluminum trays were used for microwave oven drying method. An LG Microwave oven with a fixed micro power (900 watts) was used for microwave oven drying.

The desiccants were poured up to one-inch height in the trays and flowers were inserted in an inverted position and then covered with the desiccants by spreading the media evenly so that the petals are completely covered and there is equal pressure on all sides of the flower. After the flowers were dried completely, the trays were tilted to remove the desiccants over and around the flowers. The dried flowers were then picked up by hand, cleaned by inverting them, and tapping the stems with the fingers slowly and gently. Any remaining desiccants were then removed with the help of a fine and soft brush. The flowers were checked at regular intervals to record the weight loss up to a standstill, indicating the completion of the drying process. At the end of the drying process, the petals of the flowers were pressed with fingers to check the presence of moisture. If moisture was still present, then the flowers were further exposed to drying methods for complete elimination of moisture. The data recorded for the standardization of drying techniques were analyzed as per standard statistical methods for Completely Randomized Design using Microsoft Excel and OPSTAT online statistical analysis software [6].

Observations were recorded on the extent of color fading in storage and damage to flowers due to the incidence of pests and diseases etc. The panel of ten semi-trained judges assessed the parameters viz., color fading and damage to flowers by scoring on a five-point scale given by Safeena [10] i.e., very low, low, medium, high, and very high 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 using sensory evaluation. The data recorded for storage studies were analyzed as per standard statistical methods for Factorial Completely Randomized Design using OPSTAT online statistical analysis software [11].

3. RESULTS AND DISCUSSION

3.1 Reduction in Weight

A significantly maximum reduction in weight (1.14g) was observed in shade drying (T1) in Rose and is presented in Table 1. Whereas in Carnation, the maximum reduction in weight (3.44g) was observed (T1) in the shade drying method (Table 2), and in Gerbera, the maximum reduction in weight (3.44g) was observed in (T5) microwave oven drying with silica gel as embedding medium (Table 3). Minimum reduction in weight of the flowers for Rose (0.72g) (T4), Carnation (2.42g), and Gerbera (1.49g) (T2) were observed in microwave oven drying with sand embedding and shade drying with sand embedding. Sand as an embedding medium without the support of heat resulted in lesser removal of moisture from flowers.

3.2 Moisture Content

Data further show that significant differences were observed in the moisture content of flowers as affected by different drying methods. Minimum moisture removal was observed in shade drying with sand embedding method (T2) for Rose (62.32%) and (T2) in Carnation (75.72%), and in shade drying without embedding (T1) for Gerbera (82.24%) flowers and is depicted in Tables 1, 2 and 3, respectively. This might be due to the large particle size and heavy weight of sand that absorbed less moisture and retained moisture for a short duration which ultimately led to fractional re-absorption by the partly dried tissues. Maximum moisture loss (87.72%) was observed in (T1) shade drying in Carnation (Table 2). Similar results were observed in Carnation cv. Master by Nirmala et al. [12]. Whereas, maximum moisture loss (73.18%) in Rose was observed in T1 (shade drying) and T5 (88.83%) in Gerbera flowers (Table 3). Both microwave oven and shade drying have been reported to significantly affect the moisture removal of flowers since higher temperature leads to rapid and efficient removal of moisture from the flowers.

3.3 Drying Duration

Shade-dried flowers of Rose, Carnation, and Gerbera took maximum time to dry (12, 15, and 14 hours respectively) and yield a medium quality of produce. Since shade drying depends greatly on relative humidity and room temperature, the low ambient room temperature

Table 1. Weight of flowers, duration of drying, and perimeter of Rose flowers as influenced by different drying methods

Treatment	Fresh weight of the flowers (g)	Dry weight of the flowers (g)	Reduction in total weight of flowers (g)	Duration required for drying of flowers (hrs)	Loss of moisture content (%)	Initial perimeter of flowers (cm)	Final perimeter of flowers (cm)	Reduction in perimeter of flowers (cm)	Percent reduction of perimeter %	Percent retention of perimeter %
T1	1.56	0.42	1.14	12	73.18	9.95	6.34	3.61	35.07	64.93
T2	1.64	0.6	1.04	9	62.32	10.84	9.42	1.42	13.01	86.99
T3	1.66	0.53	1.13	5.3	67.57	11.14	9.65	1.49	13.36	86.64
T4	1.08	0.36	0.72	0.07	64.47	11.05	9.92	1.13	10.38	89.62
T5	1.1	0.36	0.74	0.06	65.56	10.24	8.79	1.44	13.83	86.17
F-test	S	S	S	S	S	S	S	S	S	S
SE(d)	0.14	0.05	0.1	0.09	0.01	0.31	0.43	0.36	0.03	0.03
CV	13.03	13.34	13.84	2.45	2.09	3.51	5.93	24.56	24.31	4.77
C.D. @ 5%	0.31	0.1	0.22	0.2	0.02	0.67	0.95	0.77	0..07	0.07

T1: control; T2, T3: shade drying method, embedded in sand and silica gel, respectively.
T4, T5: microwave oven drying, embedded in sand and silica gel, respectively

Table 2. Weight of flowers, duration of drying, and perimeter of Carnation flowers as influenced by different drying methods

Treatment	Fresh weight of the flowers (g)	Dry weight of the flowers (g)	Reductio n in total weight of flowers (g)	Duration required for drying of flowers (hrs)	Loss of moisture content(%)	Initial perimeter of flowers (cm)	Final perimeter of flowers (cm)	Reduction in perimeter of flowers (cm)	Percent reduction of perimeter %	Percent retention of perimeter %
T1	3.81	0.46	3.44	15	87.72	11.14	9.65	1.49	13.36	86.64
T2	3.18	0.76	2.42	14	75.72	11.05	9.92	1.13	10.38	89.62
T3	2.95	0.42	2.51	6.5	85.37	10.24	8.79	1.44	13.83	86.17
T4	3.54	0.76	2.71	0.15	76.83	11.64	9.88	1.76	14.79	85.21
T5	3.31	0.68	2.66	0.12	79.11	10.36	8.81	1.55	14.48	85.52
F-test	S	S	S	S	S	S	S	S	S	S
SE(d)	0.13	0.09	0.15	0.13	0.06	0.31	0.43	0.36	0.03	0.03
CV	4.81	18.11	6.5	2.75	3.92	3.51	5.93	24.56	24.31	4.77
C.D. @5%	0.29		0.33		0.06	0.67	0.95	0.77	0.07	0.07

Table 3. Weight of flowers, duration of drying, and perimeter of Gerbera flowers as influenced by different drying methods

Treatment	Fresh weight of the flowers (g)	Dry weight of the flowers (g)	Reduction in total weight of flowers (g)	Duration required for drying of flowers (hrs)	Loss of moisture content(%)	Initial perimeter of flowers (cm)	Final perimeter of flowers (cm)	Reduction in perimeter of flowers (cm)	Percent reduction of perimeter %	Percent retention of perimeter %
T1	4.2	1.63	2.57	14	82.24	16.73	12.9	3.82	23.08	76.92
T2	3.11	1.62	1.49	7.6	83.18	16.42	14.83	1.58	9.82	90.18
T3	4.19	1.58	2.61	5	85.21	15.77	13.33	2.44	16.12	83.88
T4	4.16	1.66	2.5	0.3	84.75	18.17	16.03	2.14	11.86	88.14
T5	4.95	1.51	3.44	0.2	88.83	17.29	14.63	2.66	16.29	83.71
F-test	S	S	S	S	S	S	S	S	S	S
SE(d)	0.31	0.04	0.28	0.09	0.01	0.79	0.94	0.5	0.03	0.03
CV	9.31	9.1	9.91	2.23	1.33	5.6	7.74	24.95	24.92	4.27
C.D. @ 5%	0.68	0.09	0.62	0.19	0.02	1.73	2.05	1.09	0.06	0.06

Table 4. Effect of different drying methods on qualitative characteristics of Rose, Carnation, and Gerbera flowers

	Rose					Carnation					Gerbera				
Treatment	Colour	Appearance	Texture	Shattering of petal	Total quality score	Colour	Appearance	Texture	Shattering of petal	Total quality score	Colour	Appearance	Texture	Shattering of petal	Total quality score
T1	1.8	0.2	0.2	1.5	3.6	0.6	0.4	0.3	0.2	1.5	1.41	0.23	0.18	0.7	2.52
T2	3.6	3.3	3.7	3.2	14	2.8	2	2	2.5	9.3	3.31	2.39	2.45	2.9	11.04
T3	3.6	3.8	3.9	3.8	15.1	3.22	4	3.8	3.4	14.4	3.81	3.81	3.67	3.71	15
T4	3.9	4	3.9	3.9	15.6	3.42	3.1	3.5	3.9	13.9	3.33	3.51	3.16	3.1	13.1
T5	3.5	3.8	3.5	4	14.8	4	3.9	4	3.9	15.8	4	3.63	3.5	3.43	14.56
F-test	S	S	S	S		S	S	S	S		S	S	S	S	
SE(d)	0.07	0.09	0.1	0.04		0.09	0.05	0.09	0.05		0.06	0.05	0.09	0.11	
CV	2.45	3.48	3.6	1.46		3.43	1.87	3.53	1.79		2.29	2.21	4.08	4.61	
CD @ 5%	0.14	0.2	0.21	0.09		0.4	0.82	0.19	0.1		1.72	2.05	1.``09	0.06	0.06

and relative humidity were inadequate to dry the flowers quickly. Microwave oven drying with the silica gel embedding method was found to be the fastest method of drying for Rose (0.06 days), Carnation (0.12 days), and Gerbera (0.20 days) respectively. This is due strong hygroscopic nature of silica gel combined with the higher temperature of the microwave oven which increases the rate of transpiration. Silica gel is composed of a vast network of interconnecting microscopic pores, which attract and hold moisture by a phenomenon known as physical adsorption and capillary condensation and thus act as a dehydrating agent as also explained by Sindhuja et al. [13].

3.4 Retention of Flower Shape

There was a maximum reduction in the perimeter for all three flowers in the shade drying method. This is because of no embedding medium to support and hold the petals in place as moisture gets removed from the surface of the flowers combined with low room temperature, which takes a longer time for drying and results in more shrinkage of petals. In this method, shriveling of flowers and withering of petals are most commonly observed. A similarly slow rate of drying and shrinking of petals under shade was reported by Aravinda [14] and Hemant et al. [15].

Maximum retention of the perimeter for Rose (89.62%) was observed in treatment T4. Earlier studies have shown that sand and silica gel are comparatively good desiccants to maintain the original shape of the flower (Table 1). Safeena et al. [16] reported that silica gel as embedding material prevents the shrinkage of flower petals. The efficacy of silica gel as embedding material in a microwave oven was also reported by Lalhruaitluangi and Khawlhring [17] in Rose, and Sudeep et al. [18] in Orchid. For Carnation, maximum percent retention of the perimeter was observed in (T2) (89.62%), and Gerbera in (T2) (86.99%) in the sand-embedded shade drying is depicted in Table 2 and Table 3 respectively.

This may be because sand does not react with water vapor released during the process of drying. It allows the water vapor to escape into the air freely thereby causing a minimum loss in the size of flowers as explained by Sindhuja et al. [13].

3.5 Visual Quality Parameters

The effect of different drying methods on the qualitative characteristics of Rose, Carnation, and Gerbera flowers is depicted in Table 4. Drying techniques except shade drying showed highly acceptable flower qualities. In Rose, the highest quality score for colour (3.90), texture (3.90), appearance (3.80), and no shattering of petals was observed when flowers were embedded in silica gel in a microwave oven. In Carnation, the maximum score for colour (4.00), texture (4.00), appearance (3.90), and no shattering of petals was observed when flowers were embedded in sand in a microwave oven. This may be due to the uniform temperature maintained inside the microwave oven which facilitated rapid, uniform, and gradual removal of moisture from the flowers. This helps in obtaining better quality dry flowers. The highest score for colour (4.00), texture (3.67), appearance (3.81), and no shattering of petals for Gerbera flowers was observed when flowers were dried in a microwave oven with sand as an embedding medium. Meman et al. [19] observed brighter-colored flowers when embedded in the sand as a medium. Singh et al. [20] had also reported that the color retention and texture of many flowers were better maintained in sand and silica gel. In the present study also, sand embedding in a microwave oven has been found to give the best quality dry flowers for Carnation and Gerbera while silica gel embedding in a microwave oven gave the best quality dry Rose. Similarly, Prasad et al. [3] reported that Rose flowers appeared almost fresh when dried in silica gel, although the colour darkened.

He also stated that colors that came out close to the original when dried in silica gel are white, yellow, and lavender. Darker colors such as red, deep pink, and orange tend to turn even darker.

4. CONCLUSION

Based on the present finding, it is concluded that the best drying methods in rose, carnation, and gerbera flowers are: treatment T3 (shade drying with silica gel) as embedding medium, treatment T5 (microwave drying with silica gel) as embedding medium, and treatment T4 (microwave oven drying with white sand) as embedding medium respectively considering drying, color retention, brittleness, texture, storage, shattering of petals and overall acceptability.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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