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Effects of Drying Temperature on Carnation Flowers: A Study of Qualitative Aesthetic Attributes

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The investigation entitled Effects of Drying Temperature on Carnation Flowers: A study of qualitative aesthetic attributes was conducted in the Laboratory, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the years 2015-16 and 2016-17. The experiment was laid out in Randomized Block Design with four replications and six treatments viz. 1, 1.5, 2, 2.5, 3 and 3.5 minutes. Cabinet oven drying for 3.5 minutes scored maximum scores for

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aesthetic acceptability, appearance, brittleness, colour, shape and texture. Maximum aesthetic acceptability scores 3.60, 3.63 and 3.61 were observed for 3.5 min. Flowers dried for 3.5 min scored maximum 3.50, 3.63 and 3.56 for appearance. Maximum color scores were 3.70, 3.63 and 3.66 for 3.5 min. Maximum brittleness scores 3.75, 3.70 and 3.73 were observed for 3.5 min. The flowers dried by hot air oven for the duration of 3.5 minutes scored maximum 3.68, 3.70 and 3.69 scores for shape. Maximum texture scores 3.73, 3.70 and 3.71 were observed for 3.5 min.

Keywords: Cabinet oven drying; carnation; dehydration of flower; dry flowers; drying temperature; drying duration.

1. INTRODUCTION

Floriculture is a farming activity in India having huge potential for generates profit, self-employment opportunities to small and marginal farmers. This business is growing quickly throughout the world in recent times. In the fiscal year 2018, the floricultural produce in India amounted to around 2.78 million metric tons. Tamil Nadu was one of the leading producers of flowers, aromatics as well as medicinal plants with above 428 thousand metric tons. The prehistoric Egyptians prepared massively complete arrangements for their dead to enjoy all that they had during this life in the next one. Many centuries later medieval monks harvested and dried the flowers and an herb by hanging bunches upside down in shade for medicinal use (Susan, 1990).

India holds a competitive position in the global dried flower trade due to its rich biodiversity, a wide variety of plant materials, and longstanding experience in floriculture. The country also benefits from affordable labor and a climate well-suited for flower cultivation and drying (Gurumurti, 1997).

The dried flower sector has witnessed rapid growth and currently accounts for over 70% of India's floriculture industry, generating more than ₹385 crore in revenue during 2013–2014. However, India's share in the international market remains low—under 1.5% in European markets and below 1% globally. The Netherlands leads the world in dried flower exports, followed by Colombia, Mexico, India, and Israel. The United States is the largest importer, with Germany, the United Kingdom, and the Netherlands also being major consumers. Other countries importing dried floral products include Canada, Japan, Italy, Hong Kong, Australia, Ethiopia, and various Western European nations (Anon., 2014).

Dried flowers are valued for their long shelf life and ability to retain beauty in both warm and cold seasons. They are becoming more popular as consumers grow more environmentally conscious, preferring sustainable and nature-based decorative items. The durability of dried flowers depends on the species, petal structure, and overall texture. These products are widely used in crafting decorative items for homes and commercial spaces (Ranjan & Misra, 2002). Globally, India, along with the Netherlands, Mexico, Israel, and Australia, is among the top exporters of dried flower products. India's export market for these products is divided into three key categories: (a) bulk dried plant parts, commonly called "botanicals," (b) potpourri, and (c) decorative floral items. Currently, India exports dried floral goods worth around ₹150 crore annually, which represents about 25% of the global dried flower market (Patil, 2007). Indian producers supply nearly 500 different types of dried plant materials to more than 20 countries.

Despite this progress, the industry faces challenges such as outdated processing technologies. Improving techniques like drying, bleaching, and dyeing is crucial, as they directly affect the appearance and quality of the final products. More research and innovation are needed to enhance product quality and ensure India remains competitive in the global dried flower industry.

Therefore, keeping the above facts in mind a study conducted on standardize processes for dried-flower production as well as value addition in flower. Flowers have forever remained an essential element of human’s being life and love intended for natural flowers is a natural feeling.

Fresh flowers, while visually appealing, tend to be costly, have a short lifespan, and are mostly available only in specific seasons. In contrast, dried flowers are long-lasting and maintain their decorative charm throughout the year, regardless of seasonal changes.The practice of drying flowers dates back centuries. Initially, dried

flowers were primarily used by botanists to create herbariums for identifying plant species (Prasad et al., 1997). An early example of flower drying methods can be found in the 1860 publication *The Florist*, which described how to dry individual flowers such as roses, pansies, and stock using sand. Although the concept of drying flowers was known in earlier times, the first organized commercial flower drying began in Germany (Jean & Lesley, 1982). Dried and preserved ornamental plants are popular due to their unique qualities such as long shelf life, aesthetic appeal, adaptability, and availability throughout the year (Joyce, 1998). These products are usually more affordable than fresh flowers and are valued for their beauty and durability (Smith, 2000).

Despite their growing popularity, the dried flower sector has not received as much research attention as compared to other branches of floriculture (Joyce, 1998). Several researchers have explored different techniques for drying flowers and ornamental parts (Bhutani, 1995). Common methods include air drying, sun drying, oven drying, microwave drying, freeze drying, and drying using embedding materials. These techniques are widely used to create decorative items like greeting cards, wall art, floral arrangements, potpourri, and more (Bhutani, 1990).

Potpourri is one of the largest segments in the dried flower industry, with a market value of around ₹55 crore in India alone. Dried flowers serve as a reliable option for florists, especially during off-seasons when fresh flowers are not readily available. They are also more affordable than fresh flowers and can be used in locations where fresh flowers may not last long (Salinger, 1987). Over the past decade, there has been a significant rise in the popularity of dried flowers, decorative plant parts, and floral crafts. Now a day, dried flowers make up more than two-thirds of India's total floriculture exports. The market is expanding rapidly at a steady rate of 8–10% every year, which presents a greater opportunity for Indian entrepreneurs to enter and grow in the global floriculture business (Singh, 2009).

2. MATERIALS AND METHODS

The investigation was conducted in the Laboratory, Department of Horticulture, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the years 2015-16 and 2016-17. The cut flowers of carnation were produced under naturally ventilated polyhouse. Carnation flowers were cultivated in the naturally ventilated polyhouse. Single standard cultivar Pink Dona of dark pink colour was used. The flowers were harvested at commercial stage when ray florets opened 3/4th. The healthy, disease free and uniform flower stems of carnation were harvested in the morning hours between 8.00 to 9.00 am. Immediately after harvest, the cut ends of the flower stalks were immersed in water. After bringing to the laboratory, the flowers were sorted for petal damage, pests and diseases. Stems of uniform size were selected and trimmed to 6 cm length and the treatments were imposed immediately. Drying method was standardized by adopting different methods as described under each experiment. The flowers were kept in trays and dried in an electrically operated cabinet oven at the temperature 600C for 1, 1.5, 2, 2.5, 3 and 3.5 minutes. At the end of drying, the petals of the flowers were pressed with fingers to check the presence of moisture. If the moisture was still present, then the flowers were further exposed for drying for complete elimination of moisture. Visual quality parameters like aesthetic acceptability, appearance, brittleness, colour, shape and texture were assessed by means of sensory evaluation. For arriving the visual score, the opinion of 10 peer members was obtained and the means were worked out based on the scored by them(Safeena, 2005).The details of the scores are Excellent- 3.5-4.0,Very good, -2.5-3.4, Good, -- 1.5-2.4, Bad -- 0.5-1.4, Very bad - 0.0-0.4.The significance of the mean difference between treatments was determined by computing the standard error and critical difference as suggested by Panse and Sukhatme (1985).

3. RESULTS AND DISCUSSION

3.1 Aesthetic Acceptability

Aesthetic acceptability of the dried carnation flowers influenced due hot air oven drying duration presented in Table 1 was found significant during the years 2015-16, 2016-17 and pooled result.

Significantly maximum scores (3.60, 3.63 and 3.61) was observed in flowers dried by embedding intreatmentT_6 (3.5 min), while, it was recorded minimum (1.08, 1.00 and 1.04, respectively) in treatment T_1 (1.0 min).

Table 1. Effect of drying temperature in cabinet oven dryer on aesthetic acceptability and appearance scores of carnation flowers

Treatment	Acceptability Scores			Appearance Scores		
Durations at 60^0 c	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
T_1-1.0 min	1.08	1.00	1.04	1.03	1.08	1.05
T_2-1.5 min	2.48	2.38	2.43	2.28	2.65	2.46
T_3-2.0 min	2.05	1.95	2.00	3.08	1.90	2.49
T_4-2.5 min	3.23	3.25	3.24	3.30	3.30	3.30
T_5-3.0 min	3.33	3.35	3.34	3.43	3.40	3.41
T_6-3.5 min	3.60	3.63	3.61	3.50	3.63	3.56
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE m±	0.19	0.19	0.14	0.16	0.15	0.14
CD at 5%	0.58	0.57	0.43	0.48	0.44	0.41

3.2 Appearance

Data pertaining to appearance score of the dried flowers as influenced by duration of hot air oven drying, presented in Table 1. Significant differences were seen for appearance scores of dried flowers due to the duration of hot air oven drying of carnation flower. The flowers dried for 3.5 min (T_6) scored significantly maximum (3.50, 3.63 and 3.56) scores, whereas duration (1.0 min) T_1 scored minimum (1.03, 1.08 and 1.05) sensory scores during the years 2015-16, 2016-17 and in pooled result, respectively. These results are in conformity with the findings of Safeena (2005), Joy Kumar (1997).

Among the different drying methods like sun, shade and hot air oven drying methods, hot air oven drying proved better for its influence on quality parameters like retention of colour, shape, appearance and texture of marigold (*Tageteserecta*) flowers (Kulkarni et al. 2004).

3.3 Colour

A perusal of the Table 2 indicates that, the difference in dry flower colour under duration of hot air oven drying is found to be statistically significant in both the years of experimentation and pooled result.

During the years 2015-16, 2016-17 and pooled result, treatment T_6 (3.5 min) scored significantly higher sensory scores (3.70, 3.63 and 3.66, respectively) for flower colour, while least score (1.88, 0.85 and 1.36, respectively) was recorded in treatment T_1 (1.0 min). Same results were recorded by Venugopal and Patil (2000), Pandya et al. (2001) who reported that, the colour and structure of the floral parts showed no change.

3.4 Brittleness

Data on brittleness of the dried carnation flowers was affected by duration of hot air oven drying presented in Table 2 was found to be significant during the years 2015-16, 2016-17 and in pooled result.

Significantly maximum scores (3.75, 3.70 and 3.73) were observed in treatment T_6 (3.5 min), whereas it was found minimum (1.45, 1.53 and 1.49) in treatment T_1 (1.0 min) during 2015-16 and in 2016-17 and in pooled result respectively.

These results were in accordance with Dilta et al*.,* (2014) who showed that, the flowers of rose cv. First Red embedded in borax and dried in oven recorded minimum flower brittleness.

3.5 Shape

The data on scores for shape of the dried flowers as influenced by the duration of hot air oven drying presented in Table 3. during both the years 2015-16, 2016-17 and pooled result.

Significant differences were seen for shape of dried flowers due to duration. The flowers dried by hot air oven for the duration of 3.5 minutes (T_6) scored significantly maximum (3.68, 3.70 and 3.69) scores for shape, whereas drying for 1.0 minutes (T_1) scored minimum (1.20, 1.30 and 1.25) sensory scores during the years 2015-16, 2016-17 and pooled result, respectively.

Among the various drying methods sun, shade and hot air oven drying methods, hot air oven drying proved better for its influence on quality parameters like retention of colour, shape, appearance and texture of marigold (*Tageteserecta*) flowers (Kulkarni et al*.,* 2004).

Table 2. Effect of drying temperature in cabinet oven dryer on colour and brittleness scores of carnation flowers

Treatment	Color Scores			Brittleness Scores		
Durations at 60^{0}c	**2015-16**	**2016-17**	**Pooled**	**2015-16**	**2016-17**	**Pooled**
T_1-1.0 min	1.88	0.85	1.36	1.45	1.53	1.49
T_2-1.5 min	2.50	2.65	2.58	2.20	2.40	2.30
T_3-2.0 min	2.75	1.90	2.33	2.53	2.65	2.59
T_4-2.5 min	3.43	3.40	3.41	3.48	3.45	3.46
T_5-3.0 min	3.48	3.43	3.45	3.58	3.55	3.56
T_6-3.5 min	3.70	3.63	3.66	3.75	3.70	3.73
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE m±	0.16	0.17	0.14	0.13	0.14	0.10
CD at 5%	0.49	0.51	0.42	0.40	0.43	0.31

Table 3. Effect of drying temperature in cabinet oven dryer on shape and texture scores of carnation flowers

Treatment	Shape Scores			Texture Scores		
Durations at 60^{0}c	**2015-16**	**2016-17**	**Pooled**	**2015-16**	**2016-17**	**Pooled**
T_1-1.0 min	1.20	1.30	1.25	1.33	1.20	1.26
T_2-1.5 min	1.35	1.35	1.35	0.75	0.88	0.81
T_3-2.0 min	1.35	1.38	1.36	1.45	1.63	1.54
T_4-2.5 min	3.50	3.58	3.54	3.50	3.38	3.44
T_5-3.0 min	3.58	3.60	3.59	3.55	3.53	3.54
T_6-3.5 min	3.68	3.70	3.69	3.73	3.70	3.71
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE m±	0.10	0.10	0.09	0.11	0.11	0.06
CD at 5%	0.31	0.30	0.27	0.34	0.34	0.17

Venugopal and Patil (2000) concluded that, helichrysum flowers dried at 50^{o}C in oven for 48 h were found to retain shape for 150-180 days.

3.6 Texture

Texture of the dried carnation flowers was affected by duration of hot air oven drying presented in Table 3 for the years 2015-16, 2016-17 and pooled result. Data on texture of dry flower as influenced by duration of the hot air oven drying was found to be significant during the years 2015-16, 2016-17 and in pooled result respectively.

Significantly, maximum texture scores (3.73, 3.70 and 3.71 respectively) were observed in treatment T_5 (3.5 min), whereas it was found minimum (0.75, 0.88 and 0.81, respectively) in treatment T_2 (1.5 min).

Among the different drying methods like sun, shade and hot air oven drying methods, hot air oven drying proved better for its influence on quality parameters like retention of colour, shape, appearance and texture of marigold (Tageteserecta) flowers (Kulkarni et al 2004). Joykumar (1997) reported that, smooth petal texture was observed in China aster and chrysanthemum flowers when embedded in silica gel and dried in hot air oven.

4. CONCLUSION

There has been a significant rise in the popularity of dried flowers, decorative plant parts, and floral crafts. Now a day, dried flowers make up more than two-thirds of India's total floriculture exports. The market is expanding rapidly at a steady rate of 8–10% every year, which presents a greater opportunity for Indian entrepreneurs to enter and grow in the global floriculture business.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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