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Effect of chemicals as pre-drying treatments on production of quality dry flowers in carnation

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Abstract
An investigation at the College of Horticulture, Hyderabad, explored the impact of seven pre-drying chemical treatments on carnation flowers (cv. Harvey) quality. These treatments were applied in a Completely Randomized Design (CRD) with four replications. The pretreated flowers were placed in a mixture of borax and silica gel (1:1, v/v) and dried in a hot air oven at 55 ± 1 °C.
The results revealed no significant differences in dry flower weight, dry flower diameter, percent moisture loss, and drying time among the carnation samples. However, the highest scores for color (3.17), shape (2.67), texture (3.25), brittleness (3.42), overall acceptability (3.70), and total carotenoid content (80.72 µg/g) were achieved with the pre-drying treatment of magnesium chloride (10%) for 5 hours. In contrast, the lowest scores were obtained with sodium bisulphite (2%) for 30 minutes. Distilled water for 30 minutes scored the lowest for brittleness (1.57), while sodium bisulphite (2%) for 30 minutes yielded a score of 1.77.
Overall, drying the pretreated flowers ($MgCl_2$ 10% for 5 hours) in a hot air oven at 55 ± 1°C using a borax + silica gel (1:1, v/v) mixture as the embedding medium resulted in higher-quality dehydrated carnation flowers.

Keywords: Carnation, pre drying soaking, magnesium chloride, dehydration, total carotenoid content, sensory score

Introduction

The global floricultural industry is rapidly expanding, offering significant potential for both domestic consumption and exports. While fresh flowers and foliage are known for their beauty, they come with high costs, perishability, and delicate nature, making it challenging to maintain their freshness for extended periods, even with the use of preservatives. Additionally, fresh flowers are not available year-round in all regions (Datta, 2004) [2]. In light of these challenges, dried and preserved ornamental products have emerged as an attractive alternative, offering qualities such as novelty, longevity, aesthetic appeal, flexibility, and availability throughout the year.

Dried ornamental plant parts are a cost-effective option that's highly sought after for their enduring and attractive appearance. They serve various decorative purposes, such as embellishing wall hangings, enriching landscape calendars, and enhancing potpourri products. In particular, the potpourri segment of the dried flower industry stands out, valued at Rs. 55 crores in India alone (Murugan *et al*., 2007) [9]. The rising demand for dried flowers is primarily propelled by shifts in global purchasing power and evolving lifestyle preferences. The future prospects of the dried flower industry are anticipated to significantly bolster the country's economy when compared to the fresh cut flowers and live plants sectors. In the recent floriculture trade, India recorded an impressive export figure for dried flowers, reaching Rs. 363.3 crores during the year 2013-14 (Perinban *et al*., 2014) [11]. Nevertheless, it is noteworthy that the potential of the Indian dry flower industry has often been overlooked or underestimated.

To bolster the dry flower industry, it is imperative to invest in further research aimed at promoting and elevating the sector. This includes the crucial task of adapting drying techniques to align with the unique flora and fauna available in Indian conditions. The carnation (*Dianthus caryophyllus* L.) often referred to as the 'divine flower' or the 'flower of the Gods,' holds a special place in the world of cut flowers. This distinction arises from its remarkable attributes, including an exceptional shelf life, a wide range of forms and colors, and its ability to withstand long-distance shipping. Surprisingly, limited organized research has been conducted on producing dried carnation flowers in India.

Additionally, the issue of petal color change (browning or darkening) during drying is common and leads to low-quality produce that commands lower prices in the market. This browning is attributed to a group of enzymes collectively referred to as "phenolase." These enzymes become active when plant tissues are injured, especially through the use of heat during the dehydration process. Chemical inhibitors of phenolase, such as sulphites (typically sodium bisulphite and sodium metabisulphite), have been successfully used in the food industry to control various browning processes. Previous research has indicated that pre-treatments with chemicals like sodium bisulphate, magnesium chloride, and magnesium sulphate exert a substantial influence on the color and quality preservation of vegetables (Harika, 2004; Bechoff, 2011) [3, 1] and flowers (Liu Yil *et al*., 2011; Liu Ming Jing, 2013; Zhu Wen-Xue *et al*., 2013; Vishnupriya and Jawaharlal, 2014) [16, 14] during the dehydration process.

Hence, the primary objective of this study is to assess the influence of pre-drying chemical treatments on the quality of dried flowers.

Materials and Methods

The experiment took place at the College of Horticulture located in Rajendranagar, Hyderabad. It involved seven different pre-drying treatments:

1. **T_1:** Soaking in a 1% sodium bisulphite solution for 30 minutes
2. **T_2:** Soaking in a 2% sodium bisulphite solution for 30 minutes
3. **T_3:** Soaking in a 5% magnesium chloride solution for 5 hours
4. **T_4:** Soaking in a 10% magnesium chloride solution for 5 hours
5. **T_5:** Soaking in a 5% magnesium sulphate solution for 4 hours
6. **T_6:** Soaking in a 10% magnesium sulphate solution for 4 hours
7. **T_7:** Control group, soaked in distilled water for 30 minutes

The carnation flowers employed in the experiment were in excellent health, free from diseases, and displayed uniform quality. They were harvested at the stage suitable for commercial use, specifically when approximately three-fourths of the ray florets had opened, typically carried out in the morning, usually between 8:00 and 9:00 am.

Upon harvesting, the cut ends of the flower stems were promptly immersed in distilled water, and the flowers were then transported to the laboratory. Every flower stem was trimmed to a consistent length of 6 cm, and any leaves attached to the stems were removed. The flowers were then soaked in their respective chemical solutions according to their designated treatments.

Subsequent to the soaking process, the flowers were taken out of the solutions. To eliminate excess water, they were gently placed on a fine cloth, allowing any surplus moisture to drain away. The flowers were then left to air dry until all visible water had evaporated. Following these pretreatments, the flowers were introduced into an embedding medium comprising a mixture of borax and silica gel, with a 1:1 ratio in terms of volume (v/v).

To expedite the drying process, plastic containers measuring 14 cm in height and 14 cm in diameter were utilized. These containers had lids. A layer of the desiccant (borax and silica gel) was poured to a depth of approximately one inch at the bottom of each container. Following that, the flower stems were gently placed into the embedding medium. Additional desiccant was poured around and over the flowers, ensuring that it filled the gaps between the petals without causing any disruption to the flower's natural shape.

The containers were then positioned inside a hot air oven and subjected to controlled drying at a temperature of 55 ± 1 °C. Following dehydration, the containers were tilted to eliminate any surplus desiccant from around and on top of the flowers. The dried flowers were carefully collected by hand, and any remaining desiccant was removed by inverting the flowers and tapping the stems gently. A fine brush was used to ensure all traces of desiccant were removed.

During the experiment, various observations were recorded, including the fresh weight of the flowers, their dry weight, the diameter of the dried flowers, the percentage of moisture loss, and the duration required for the flowers to complete the drying process.

Estimation of Total Carotenoid Content

The determination of the total carotenoid content was carried out in accordance with the procedure outlined by Zakaria *et al*. in 1979, and the steps are described as follows:

1. Saponification

- Place approximately 1 ± 0.5 grams of the homogenized sample into a 100 ml conical flask.
- Dissolve the sample by adding 10 ml of a freshly prepared working alcoholic KOH solution.
- Allow the flask to incubate at 37 °C for 30 minutes, shaking it periodically during this period.
- Once saponification is complete, transfer the contents to a separating funnel to proceed with the extraction process.

2. Extraction of Total Carotenoids

- Extract the saponified mixture by using 50 ml of petroleum ether for each extraction in a separating funnel.
- After each extraction, combine the upper solvent layer into a separate 250 ml conical flask.
- Return the lower alcohol layer back to the separating funnel for the subsequent extraction.
- Repeat the extraction process 3-4 times or until you achieve a clear white layer, indicating complete extraction.
- After the final extraction, carefully pour the pooled petroleum ether layer into the separating funnel, discarding the lower layer.
- Wash the pooled solvent three times with distilled water.
- Transfer the washed solvent into a conical flask and introduce 20-30 grams of anhydrous sodium sulfate to remove excess water.
- Shift the solvent to a 100 ml measuring cylinder, measure and record the volume as "y."
- Determine the optical density (OD) of the solution (x) at a wavelength of 450 nm using a spectrophotometer (UV-VIS, CE 7400).

Observations

- Optical Density (O.D) of the sample, x = -------------
- Volume of the pooled extract, y = ------------- ml

- Sample weight, z = ------------- grams

Calculations

- 1 OD = 4 µg/ml (10000/2500)
- "x" OD = 4 * x µg
- "y" ml contains 4 * x * y µg of total carotenoids
- 4xy µg is derived from "z" mg of the sample

$$\text{Therefore, } \text{-----------------} = \frac{4xy \times 100}{z\ g}\ \mu g\ \%$$

Result

The total carotenoid content is expressed in µg per 100 grams of the provided sample.

A panel consisting of five judges conducted assessments on multiple quality parameters, which encompassed aspects such as color, shape, texture, brittleness, and overall acceptability. They scored these parameters on a five-point scale, ranging from excellent (3.5-4.0) to very bad (0.0-0.4). The data underwent analysis employing a Completely Randomized Design (CRD), following the methodology delineated by Panse and Sukhatme in 1985.

Results and Discussion

The data analysis of the effect of various pre-drying treatments with chemical salts on carnation flowers (cv. Harvey) revealed several significant findings:

1. **Dry Flower Weight, Diameter, Moisture Loss, and Drying Time:** The pre-drying treatments did not result in significant differences in dry flower weight, dry flower diameter, percentage of moisture loss, or the time required for drying. (Table 1).
2. **Color:** The most significant and highest color scores were observed when the flowers were subjected to treatment with magnesium chloride (10%) for duration of 5 hours (3.17), followed by treatment with magnesium sulphate (5%) for 4 hours (2.02). This suggests that these treatments effectively preserved the color of the flowers. Magnesium chloride is known for its role in inhibiting browning in petals, likely contributing to the improved color (Table 2).
3. **Shape:** Significant differences were observed in the shape of dried carnation flowers. The highest shape scores were obtained when the flowers were treated with magnesium chloride (10%) for 5 hours (2.67), closely followed by treatment with magnesium sulphate (5%) for 4 hours (2.27). The shape was least favorable when the flowers were treated with sodium bisulphite (2%) for 30 minutes (1.70), similar to those treated with distilled water for 30 minutes (1.75) (Table 2).
4. **Texture:** The pre-drying treatments had a substantial impact on the texture of the dried carnation flowers. The highest texture score was achieved with magnesium chloride (10%) treatment for duration of 5 hours (3.25), followed by magnesium sulphate (5%) treatment for 4 hours (2.22). Sodium bisulphite (2%) treatment for 30 minutes resulted in the lowest texture score (1.52) (Table 2).
5. **Brittleness:** The highest brittleness scores were obtained when the flowers were subjected to treatment with magnesium chloride (10%) for 5 hours (3.42), closely followed by treatment with magnesium sulphate (5%) for 4 hours (2.37). The flowers treated with distilled water for 30 minutes (1.57) or sodium bisulphite (2%) for 30 minutes (1.77) showed the lowest brittleness scores (Table 3).
6. **Overall Acceptability:** Flowers treated with magnesium chloride (10%) for 5 hours received the highest overall acceptability score (3.70), while flowers subjected to treatment with sodium bisulphite (2%) for 30 minutes received the lowest overall acceptability score (0.20) (Table 3).
7. **Total Carotenoid Content:** The pre-drying treatments significantly influenced the total carotenoid content. The highest retention of total carotenoids was observed in flowers subjected to treatment with magnesium chloride (10%) for 5 hours (80.72 µg/g), closely followed by treatment with magnesium sulphate (5%) for 4 hours (62.16 µg/g). The lowest carotenoid content was recorded in flowers when subjected to treatment with sodium bisulphite (2%) for 30 minutes (17.86 µg/g).

Table 1: Effect of pre-drying chemical treatments on dry flower weight (g), dry flower diameter (cm), per cent moisture loss (%) and time taken to dry (hours) in carnation cv. Harvey

Treatments (T)	Dry flower weight (g)	Dry flower diameter (cm)	Per cent moisture loss (%)	Time taken to dry (hours)
T_1 - Soaking in a 1% sodium bisulphite solution for 30 minutes	1.52	3.45	75.83	44.50
T_2 - Soaking in a 2% sodium bisulphite solution for 30 minutes	1.62	3.55	75.98	44.12
T_3 - Soaking in 5% magnesium chloride solution for 5 hours	1.68	3.35	75.43	44.00
T_4 - Soaking in 10% magnesium chloride solution for 5 hours	1.67	3.47	74.60	43.68
T_5 - Soaking in 5% magnesium sulphate solution for 4 hours	1.63	3.42	74.27	43.37
T_6 - Soaking in 10% magnesium sulphate solution for 4 hours	1.65	3.50	74.78	44.25
T_7 - Control group, soaked in distilled water for 30 minutes	1.58	3.41	75.59	44.06
S.Em±	0.03	0.06	0.83	0.33
CD at 5%	NS	NS	NS	NS

Table 2: Effect of pre-drying chemical treatments on colour, shape and texture of dried carnation cv. Harvey as assessed through sensory evaluation

Treatments (T)	Colour	Shape	Texture
T_1 - Soaking in a 1% sodium bisulphite solution for 30 minutes	0.47	1.81	1.80
T_2 - Soaking in a 2% sodium bisulphite solution for 30 minutes	0.10	1.70	1.52
T_3 - Soaking in 5% magnesium chloride solution for 5 hours	1.77	1.90	2.17
T_4 - Soaking in 10% magnesium chloride solution for 5 hours	3.17	2.67	3.25
T_5 - Soaking in 5% magnesium sulphate solution for 4 hours	2.02	2.27	2.22
T_6 - Soaking in 10% magnesium sulphate solution for 4 hours	1.45	1.78	2.02
T_7 - Control group, soaked in distilled water for 30 minutes	1.52	1.75	2.07
S.Em±	0.04	0.06	0.05
CD at 5%	0.13	0.20	0.16

Table 3: Effect of pre-drying chemical treatments on brittleness, overall acceptability and total carotenoid content (µg/g) of dried carnation cv. Harvey

Treatments (T)	Brittleness	Overall acceptability	Total Carotenoid content (µg/g)
T_1 - Soaking in a 1% sodium bisulphite solution for 30 minutes	1.95	0.82	19.28
T_2 - Soaking in a 2% sodium bisulphite solution for 30 minutes	1.77	0.20	17.86
T_3 - Soaking in 5% magnesium chloride solution for 5 hours	2.20	2.25	61.26
T_4 - Soaking in 10% magnesium chloride solution for 5 hours	3.42	3.70	80.72
T_5 - Soaking in 5% magnesium sulphate solution for 4 hours	2.37	2.52	62.16
T_6 - Soaking in 10% magnesium sulphate solution for 4 hours	1.90	1.72	19.62
T_7 - Control group, soaked in distilled water for 30 minutes	1.57	1.75	23.43
S.Em±	0.09	0.08	0.82
CD at 5%	0.26	0.24	2.44

Conclusion

In conclusion, the data strongly support the conclusion that the optimal approach involves initially treating carnation flowers with magnesium chloride (10%) for 5 hours, followed by subsequent drying in a hot air oven using a borax + silica gel (1:1, v/v) embedding medium at a controlled temperature of 55 ± 1 °C, resulted in the production of superior-quality dehydrated flowers characterized by enhanced attributes such as color, shape, texture, brittleness, overall acceptability, and higher carotenoid content. This treatment effectively countered the degradation of carotenoids and contributed to the preservation of flower quality during the drying process.

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