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QUANTITATIVE ANALYSIS OF QUALITY ATTRIBUTES IN LISIANTHUS (*Eustoma grandiflorum*) VARIETIES AS INFLUENCED BY DRYING TECHNIQUES AND DESICCANT TREATMENTS

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ABSTRACT

Lisianthus (*Eustoma grandiflorum*) a member of the Gentianaceae family, is also known by names like prairie gentian, Texas bluebell, tulip gentian and blue bells. This plant is an annual or short lived perennial herb, reaching a height of up to 80 cm. Its leaves are simple, opposite and sessile in nature. The flowers are vibrant, borne on long pedicels and are terminal and solitary. As a rising star among cut flowers, *Eustoma grandiflorum* often referred to as *E. russellianum* or 'Texas bluebell', is native to Colorado, Kansas, Nebraska and Texas, where it thrives as an annual or biennial species. A 2024–25 study at the College of Horticulture, Bagalkot, evaluated drying methods for Lisianthus. The flowers dried by using different drying methods and desiccants had significant influence on dry weight, moisture loss, final moisture retention and reduction in flower diameter Sand embedded flowers dried under hot air oven recorded minimum dry weight ($V_2D_2M_1$) (0.49 g/ flower), while flowers embedded with silica gel showed highest moisture loss ($V_1D_2M_2$) (91.15 %).
***Keywords* :** Lisianthus, Varieties, Drying Methods, Desiccants, Preservation.

Introduction

Lisianthus (*Eustoma grandiflorum*) is a highly valued ornamental flower known for its delicate, rose-like blooms and vibrant colours. Lisianthus is a captivating flowering plant admired for its delicate, rose-like blooms and vibrant colours ranging from white and pink to deep purple and blue. In summer, the plants produce bell shaped, satin like flowers that are pale purple with darker center, either blooming individually or clustered together. Over the past 20 years, this species has been extensively hybridized, resulting in numerous series with unique colour variants and stand alone cultivars. The colour range from pink, purple, red, white and yellow to various combinations, including singles and doubles, with diverse patterns and seasonal adaptability Widely used in floral arrangements and decorative displays, its aesthetic appeal and symbolic significance make it a favorite in both domestic and commercial floriculture. However, like many cut flowers, Lisianthus is highly perishable, limiting its shelf life and market potential. To overcome this challenge, flower drying techniques have emerged as a sustainable solution to preserve its beauty and extend usability. Standardizing these drying methods such as shade drying, desiccant drying and hot air oven drying, Is essential to ensure consistent quality, colour retention and structural integrity of dried Lisianthus blooms. (Darvesh *et al.*,2021).

Material and Methods

The present investigation entitled was done to understand the effect of different drying techniques and desiccants for cut flower that can be used for value addition. The details of the materials used and the procedure adopted in the investigation, which was carried out at Departmental Laboratory, Department of Postharvest Management, College of Horticulture, Lisianthus var. Rosita clear pink and Rosita bright blue were collected in the month of December to Jaunary as it is the peak time to collect the desired flower. There are two drying methods (Hot air oven, Shade drying) and three desiccants (Sand, Silica gel and Vermiculite). The experiment was laid out in factorial completely randomized design with three replications. Under this experiment, Overall 12 treatments comprising of different drying techniques with desiccants. Treatment comprised of T_1(Rosita clear pink+ sand+ Hot air oven), T_2(Rosita clear pink+ sand+ Shade dry), T_3(Rosita clear pink + Silica gel + Hot air oven), T_4(Rosita clear pink+ Silica gel+ Shade dry), T_5(Rosita clear pink +Vermiculite+ Hot air oven), T_6(Rosita clear pink+ Vermiculite+ Shade dry), T_7(Rosita bright blue+ Sand+ Hot air oven), T_8(Rosita bright blue+ Sand+ Shade dry), T_9(Rosita bright blue+ Silica gel +Hot air oven), T_{10}(Rosita bright blue+ Silica gel+ Shade dry), T_{11}(Rosita bright blue +Vermiculite+ Hot air oven), T_{12}(Rosita bright blue+ Vermiculite+ Shade dry). The analysis was done using the formula of Fisher and Yates. The quality score was done using 9 point hedonic scale.

Results and Discussion

Time taken for drying (h)

The drying duration of lisianthus flowers varied across cultivars, desiccants, and methods. Rosita clear pink (V_1) dried slightly faster (81.80 h) than Rosita bright blue (V_2) (81.83 h). Silica gel (D_2) was the most effective desiccant (67.50 h), followed by river sand (84.00 h) and vermiculite (94 h). Hot air oven drying (M_1) was fastest (30 h), while shade drying (M_2) took 144 h. The combination $V_1D_2M_1$ (Rosita clear pink + silica gel + hot air oven) had the shortest drying time (24 h). $V_1D_1M_2$ (Rosita clear pink + river sand + shade drying) took the longest (168 h). $V_1D_3M_2$ (Rosita clear pink + vermiculite + shade drying) required 144 h. These results show the impact of cultivar, desiccant, and method on drying time. The findings align with previous studies on embedded drying systems.

Drying media significantly influence flower moisture loss rates. Silica gel, noted by Stern (1994), showed the fastest drying among tested desiccants. Its high absorption capacity enabled quick dehydration of flowers like calendula and dahlia (Roberts, 2000). In this study, silica gel dried lisianthus var. Rosita clear pink in just 24 hours. Shade drying with riverbed sand was slowest, taking 168 hours. These findings align with Sindhuja *et al.* (2015), who confirmed silica gel's superiority. Faster drying improves flower quality and reduces processing time. Silica gel thus proves efficient and cost-effective. It supports large-scale dry flower production. This makes it ideal for export purposes.

Table 1 : Fresh weight and time taken for drying of dried Lisianthus flowers during storage as influenced by various desiccants and drying methods.

Treatments	Fresh weight (g/flowers)	Time taken for drying(hrs)
Variety		
V_1	4.73	81.80
V_2	4.65	81.83
S.Em ±	**0.03**	**0.01**
C.D. at 1 %	**0.10**	**0.03**
Desiccant		
D_1	4.53	94.00
D_2	4.78	67.50
D_3	4.81	84.00
S.Em ±	**0.03**	**0.01**
C.D. at 1 %	**0.13**	**0.03**
Method		
M_1	4.77	30.00
M_2	4.65	144.00
S.Em ±	**0.03**	**0.01**
C.D. at 1 %	**0.10**	**0.03**
Interactions		
$V_1D_1M_1$	4.23	30.00
$V_1D_1M_2$	4.57	168.00
$V_1D_2M_1$	4.38	24.00
$V_1D_2M_2$	5.65	120.00
$V_1D_3M_1$	4.55	26.00
$V_1D_3M_2$	5.24	144.00
$V_2D_1M_1$	4.85	30.00
$V_2D_1M_2$	4.48	168.00
$V_2D_2M_1$	4.53	23.00
$V_2D_2M_2$	4.58	120.00
$V_2D_3M_1$	4.46	26.00
$V_2D_3M_2$	4.98	144.00
Mean	4.70	85.33
S.Em ±	**0.06**	**0.02**
C.D. at 1 %	**0.26**	**0.07**

$\mathbf{V_1}$= Rosita clear pink $\mathbf{D_1}$= Sand $\mathbf{M_1}$= Hot air oven drying
$\mathbf{V_2}$= Rosita bright blue $\mathbf{D_2}$= Silica gel $\mathbf{M_2}$= Shade drying
$\mathbf{D_3}$= Vermiculite

Dry weight (g)

Dry weight of lisianthus flowers increased over time, with Rosita clear pink (V1) recording 0.66, 0.69, and 0.73 g per flower at 30, 60, and 90 days, higher than Rosita bright blue (V2) at 0.60, 0.62, and 0.66 g.

Among desiccants, sand (D1) gave the highest weights (0.72, 0.76, 0.80 g), followed by silica gel (D2) (0.60, 0.61, 0.66 g), and vermiculite (D3) (0.57, 0.59, 0.63 g). Hot-air oven drying (M1) yielded more than shade drying (M2), with 0.66, 0.69, 0.73 g vs. 0.60, 0.62, 0.66 g. The lowest weight was in $V_2D_2M_2$ (0.46, 0.49, 0.53 g), and the highest in $V_1D_1M_1$ (0.87, 0.93, 0.97 g). Interaction effects among variety, desiccant, and method were significant throughout.

There was significant differences among the treatments over storage period with respect to dry weight due to different drying methods and desiccants. Up to 30 days minimum dry weight ($V_2D_2M_2$ 0.44 and 0.46 g/ flower) was noticed in the flowers those dried by using shade dry with silica gel as an embedding medium for 120.00 hrs. This could be due to the longer exposure of flowers to silica gel, which resulted in better moisture removal (Adiga *et al.*, 2013). These results were in line with findings of Dahiya *et al.*, (2003).

After 90 days of storage, the lowest dry weight (0.49 and 0.53 g/flower) was recorded in flowers dried using silica gel for 120 h under shade, due to its strong hygroscopic nature. This aligns with Deshraj and Gupta (2003), who found silica gel (60–120 mesh) to be the most effective moisture absorbent, followed by boric acid granules. In contrast, flowers dried in vermiculite ($V_1D_3M_2$) showed the highest dry weight, likely due to poor moisture removal. Similar findings were reported by Singh *et al*. (2003) in zinnia.

Moisture loss (%)

Moisture loss in dried lisianthus varied significantly across embedding media and decreased over time. In table 2 Rosita clear pink (V_1) showed the highest loss at 87.09%, 86.66% and 85.80% after 30, 60 and 90 days, while Rosita bright blue (V_2) had the lowest at 86.64%, 85.41% and 84.56%. Silica gel recorded the highest moisture loss (87.44%, 87.23%, 86.19%), followed by vermiculite (88.14%, 87.73%, 86.90%). Sand showed the least moisture loss: 84.10%, 83.22% and 82.33% across the same intervals. These results highlight the influence of variety and desiccant on moisture retention.

Table 2 : Dry weight and Moisture loss of dried Lisianthus flowers during storage as influenced by various desiccants and drying methods

Treatments	**Dry weight(g/flowers)**				**Moisture loss (%)**			
	DAS							
Variety	**Initial**	**30**	**60**	**90**	**Initial**	**30**	**60**	**90**
V_1	0.63	0.66	0.69	0.73	87.52	87.09	86.66	85.80
V_2	0.58	0.60	0.62	0.66	86.68	86.64	85.41	84.56
S.Em ±	**0.01**	**0.01**	**0.01**	**0.01**	**0.30**	**0.28**	**0.27**	**0.18**
C.D. at 1 %	**0.02**	**0.02**	**0.02**	**0.02**	**1.17**	**1.11**	**1.07**	**0.72**
Desiccant								
D_1	0.70	0.72	0.76	0.80	84.54	84.10	83.22	82.33
D_2	0.57	0.60	0.61	0.66	88.07	87.44	87.23	86.19
D_3	0.54	0.57	0.59	0.63	88.77	88.14	87.73	86.90
S.Em ±	**0.01**	**0.01**	**0.01**	**0.01**	**0.36**	**0.34**	**0.33**	**0.22**
C.D. at 1 %	**0.02**	**0.03**	**0.02**	**0.03**	**1.43**	**1.36**	**1.31**	**0.88**
Method								
M_1	0.63	0.66	0.69	0.73	86.79	86.16	85.53	84.69
M_2	0.58	0.60	0.62	0.66	87.52	87.09	86.66	85.80
S.Em ±	**0.01**	**0.01**	**0.01**	**0.01**	**0.30**	**0.28**	**0.27**	**0.18**
C.D. at 1 %	**0.02**	**0.02**	**0.02**	**0.02**	**1.17**	**1.11**	**1.07**	**0.72**
Interactions								
$V_1D_1M_1$	0.83	0.87	0.93	0.97	80.37	79.43	78.01	77.06
$V_1D_1M_2$	0.56	0.58	0.62	0.67	87.74	87.30	86.43	85.33
$V_1D_2M_1$	0.48	0.52	0.54	0.58	90.83	90.07	89.69	88.93
$V_1D_2M_2$	0.50	0.52	0.55	0.57	91.15	90.79	90.26	89.91
$V_1D_3M_1$	0.56	0.58	0.61	0.63	87.69	87.25	86.59	86.15
$V_1D_3M_2$	0.84	0.86	0.89	0.95	80.82	80.36	79.68	78.31
$V_2D_1M_1$	0.81	0.83	0.85	0.88	83.29	82.88	82.47	81.85
$V_2D_1M_2$	0.61	0.62	0.65	0.68	86.38	86.16	85.49	84.82
$V_2D_2M_1$	0.49	0.51	0.53	0.58	89.18	88.61	88.16	87.05
$V_2D_2M_2$	0.44	0.46	0.49	0.53	90.39	89.95	89.30	88.42
$V_2D_3M_1$	0.55	0.57	0.60	0.64	87.66	87.21	86.54	85.65

$V_2D_3M_2$	0.57	0.59	0.61	0.65	88.55	88.15	87.75	86.94
Mean	0.60	0.62	0.65	0.69	87.00	86.51	85.86	85.03
S.Em ±	**0.02**	**0.01**	**0.01**	**0.02**	**0.72**	**0.69**	**0.66**	**0.44**
C.D. at 1 %	**0.06**	**0.06**	**0.05**	**0.06**	**2.87**	**2.73**	**2.63**	**1.76**

DAS: Days after storage
V_1= Rosita clear pink **D_1**= Sand **M_1**= Hot air oven drying
V_2= Rosita bright blue **D_2**= Silica gel **M_2**= Shade drying **D_3**= Vermiculite

Shade drying showed the highest moisture loss in lisianthus flowers at 87.09%, 86.66%, and 85.80% after 30, 60 and 90 days, while hot-air oven drying had the lowest at 86.16%, 85.53% and 84.69%. The $V_1D_2M_2$ combination (Rosita clear pink + silica gel + shade drying) recorded the maximum loss: 90.79%, 90.26% and 89.91%. In contrast, $V_1D_1M_1$ (Rosita clear pink + sand + hot-air oven) had the minimum: 79.43%, 78.01%, and 77.06%. These results highlight significant interaction effects among drying method, desiccant, and variety.

Moisture loss in dried lisianthus varied significantly with desiccants, with silica gel showing the highest loss at 91.15%. Its strong absorption capacity (up to 40%) makes it ideal for tight-petaled flowers like rose (Pertuit, 2002). Similar findings were reported by Gupta and Prashant (2005) Safeena *et al*., (2006), and Deepthi *et al*. (2008) in other flower types. These results confirm silica gel's effectiveness in moisture removal.

The lower moisture loss (80.37 %) in sand embedded flowers could be attributed due to the lesser dehydrating properties of sand in comparison with silica gel and vermiculite, which resulted in insufficient removal of moisture. This was in accordance with the results obtained by Nirmala *et al.* (2008) and Whitte *et al.* (2007).

Conclusion

The various desiccants and drying methods were used to maintained the quality of dried lisianthus var Rosita clear pink and Rosita bright blue. The salient findings are listed below.

Desiccant Efficiency: Silica gel was identified as the most effective desiccant for preserving the quality of dried cut chrysanthemum flowers.

1. **Optimal Drying Method**: Embedding flowers in silica gel and drying them in a hot air oven at 50°C yielded superior results in terms of structural integrity, colour retention and overall aesthetic quality for lisianthus.
2. **Varietal Performance-** Among the tested lisianthus cultivars, 'Rosita bright blue' demonstrated better retention of sensory attributes—such as colour, petal texture and shape compared to 'Rosita clear pink'.

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