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Standardization of different desiccants for drying of Helichrysum (*Helichrysum bracteatum*)

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Abstract
The experiment "Standardization of Different Desiccants for Drying of Helichrysum (*Helichrysum bracteatum*) was conducted at the Dry Flower Laboratory, IGKV, Raipur, during 2023-24 in a Completely Randomized Design (CRD) with three replications and eleven desiccant treatments: T_1 Silica gel (Control), T_2 Borax, T_3 River sand, T_4 Vermiculite, T_5 Sawdust, T_6 Cornmeal, T_7 Borax + River sand 1:1, T_8 Borax + River sand 2:1, T_9 Borax + Cornmeal 2:1, T_{10} Silica gel + River sand 1:1, and T_{11} Sawdust + River sand 2:1. among them, T_1 recorded the lowest dry flower weight (0.41 g), highest moisture loss (81.22%), and shortest drying time (2.5 days) followed by T_{10}. Qualitative parameters were also significantly influenced by desiccants, treatment T_1 achieving the highest sensory scores for appearance (8.02), texture (8.08), and brittleness (7.29) followed by T_{10}. These findings indicate that silica gel and its combinations are the most effective desiccants for preserving Helichrysum flowers with superior drying quality.

Keywords: Drying, desiccants, embedding media, silica gel and helichrysum

Introduction
Helichrysum bracteatum commonly known as the golden everlasting or strawflower belongs to the Asteraceae family and is native to Australia. these half-hardy plants grow 50-90 cm tall with dark green, branched stems and narrow leaves. their true petals are surrounded by colourful, straw-like bracts, forming golden yellow or white flower heads that bloom from spring to autumn. Fully open flowers are collected and dried upside down in a cool place after that stored in airtight containers for use in dried and exotic arrangements. Drying is a conventional method that removes moisture from flowers while preserving their aesthetic value. However, natural drying methods such as sun and air drying often lead to discoloration due to oxidative reactions that occur during desiccation, affecting the visual appeal of plant materials. To overcome this, artificial drying techniques like hot air oven drying, microwave drying and freeze drying have been developed (Bhutani,1995) [1]. Additionally, embedding flowers in desiccants such as silica gel, river sand and borax helps maintain their shape and colour for extended periods (Singh *et al.*,2004) [13]. These advanced drying methods have gained popularity for producing high-quality dried flowers suitable for long-lasting floral arrangements.

Materials and Methods
The study *"*Standardization of Different Desiccants for Drying of Helichrysum (*Helichrysum bracteatum*)*"* was conducted at the Dry Flower Laboratory, Department of Floriculture and Landscape Architecture, IGKV, Raipur, during 2023-24. Helichrysum flowers were collected from the Floriculture Research Field near the Precision Farming Development Centre (PFDC), IGKV, Raipur. Seedlings were transplanted into polybags in late November and carefully cultivated before harvest. Fully open, healthy, and disease-free flowers were harvested in the morning (6:30-8:00 AM) using sharp scissors and immediately transported to the laboratory for treatment. The experiment followed a Completely Randomized Design (CRD) with three replications and eleven treatments: T_1(Silica gel) (control), T_2 (Borax), T_3(River sand), T_4(Vermiculite), T_5(Sawdust), T_6 (Cornmeal), T_7 (Borax + River sand 1:1), T_8(Borax + River sand 2:1), T_9 (Borax + Cornmeal 2:1), T_{10}(Silica gel + River sand 1:1) and

T_{11}(Sawdust + River sand 2:1). The flowers were dried using desiccants Silica gel, River sand, Borax, Vermiculite, Sawdust, Cornmeal, and their combinations. Plastic trays were layered with 1 inch of desiccant, and flowers were placed upright at the center. Desiccant was gently poured around and over the flowers, covering them 2 inches above to maintain their shape. The trays were then kept in a well-ventilated room at room temperature with regular checks for dryness.

Results and Discussion

Qualitative parameters

Fresh weight of flowers (g)

Utmost care was taken to select disease-free plants to ensure high-quality flowers for drying treatments, the average fresh weight of helichrysum flowers ranged between 1.42 g to 1.52 g, reflecting uniformity in the initial flower material used for the experiment.

Dry weight of the flowers(g)

The dry weight of Helichrysum flowers varied significantly depending on the desiccant used. The lowest dry weight (0.417 g/flower) was observed with T_1 silica gel followed by treatment T_{10} (0.424 g) with silica gel + river sand (2:1) both found to be statistically at par. The highest dry weight (0.532 g) was recorded in treatment T_3 (sand). Silica gel due to its high moisture absorption properties, resulted in the lowest dry weight. This is because silica gel made from sodium silicate contains microscopic pores that attract and absorb moisture (Safeena *et al.*, 2006) [10]. On the other hand, sand, with larger particles and lower moisture retention capacity led to a higher dry weight as it reabsorbed moisture less effectively (Dilta *et al.*, 2014) [3]. These findings are supported by previous studies (Gantait and Mahato, 2014; Singh and Dhaduk, 2005; Sindhuja *et al.*, 2015) [4, 12, 11].

Moisture Loss of flowers (%)

Flowers embedded in T_1 (silica gel) showed the highest moisture loss (81.22%), followed by T_{10} (silica gel + river sand, 80.51%), while T_2 (sand) had the lowest moisture loss (69.45%). Silica gel's high moisture loss is due to its extensive network of microscopic pores that absorb moisture through physical adsorption and capillary condensation (Safeena *et al.*, 2006) [10]. This result aligns with findings by Nair and Singh (2011) [7], and similar observations were made by Dilta *et al.*, (2014) [3] in cut roses. T_3 embedding in Sand, with larger particles and heavier weight, absorbs less moisture and cannot retain it for long, leading to reabsorption by the flowers as also noted by Radha Rani and Reddy (2015) [9] in Marigold flowers.

Times taken for drying

Significant differences were observed in the drying time of Helichrysum flowers with various desiccants. The longest drying time (7.6 days) was recorded with T_6 (cornmeal) while the shortest (2.5 days) was in T_1 (silica gel) followed by T_{10} (silica gel + river sand 1:1) at 3.6 days. Silica gel strong hygroscopic nature resulted in the fastest drying followed by sand and borax. This is because silica gel, made from sodium silicate contains microscopic pores that absorb moisture through physical adsorption and capillary condensation. Similar findings were reported by Sindhuja *et al.*, (2015) [11] in carnations, Jagadeeswari *et al.*, (2021) [5] in gerbera, and Chandana *et al.*, (2021) [2] in chrysanthemums. Vermiculite (T_4) took the longest drying time due to its low hygroscopicity and slower moisture absorption, as it primarily absorbs water into its layered structure rather than onto its surface like silica gel.

Table 1: Effect of different desiccants on fresh weight, Dry weight, moisture loss and times taken for drying of helichrysum flowers.

Tr. No.	Treatment	Fresh weight (g)	Dry weight (g)	Moisture loss (%)	Times taken for drying
T_1	Embedding in silica gel	1.528	0.417	81.22	2.5
T_2	Embedding in borax	1.460	0.457	79.13	4.5
T_3	Embedding in river sand	1.456	0.532	69.45	6.2
T_4	Embedding in vermiculite	1.471	0.489	70.72	7.6
T_5	Embedding in sawdust	1.449	0.466	74.03	6.3
T_6	Embedding in cornmeal	1.478	0.462	72.20	7.4
T_7	Embedding in borax + river sand (1:1)	1.474	0.522	73.54	5.6
T_8	Embedding in borax + river sand (2:1)	1.433	0.518	74.81	4.6
T_9	Embedding in borax + cornmeal (2:1)	1.425	0.479	73.13	5.8
T_{10}	Embedding in silica gel + river sand (1:1)	1.517	0.424	80.51	3.6
T_{11}	Embedding in sawdust + River sand (2:1)	1.472	0.505	72.87	5.7
	S.Em ±	0.007	0.004	0.252	0.06
	CD at 5%	0.022	0.011	0.742	0.18

Qualitative parameters

Flower colour

Helichrysum flowers dried with T_1 (silica gel) showed the best results, retaining superior colour, texture, and overall quality. T_{10} (silica gel + river sand 1:1) also performed well in preserving the flowers aesthetic appeal. These findings align with previous studies by Kumari and Peiris (2000) [6], Singh and Dhaduk (2005) [12], Safeena *et al.*, (2006) [10], Jagadeeswari *et al.*, (2021) [5], and Chandana *et al.*, (2021) [2], all the scientist highlighted silica gel's effectiveness in retaining flower quality, colour, and structural integrity. Overall, silica gel and its combinations are among the most reliable methods for drying Helichrysum flowers while maintaining their ornamental value.

Plate 2: colour code of best treatments as per RHS colour chart

Flower appearance

The study evaluated the appearance of dried Helichrysum flowers subjected to different desiccant treatments. The highest appearance score (8.02) was recorded for T_1 (silica gel), followed by T_{10} (silica gel + river sand 1:1) with a score of 7.91. The lowest score (4.70) was observed in T_3 (river sand). Silica gel and its combinations performed best in preserving flower appearance due to their strong moisture absorption and desiccation properties. Silica gel's high surface area and hygroscopic nature efficiently absorb moisture, preventing wilting and maintaining the flowers natural shape and colour. These results are consistent with Nair and Singh (2011) [7] and Sindhuja *et al.*, (2015) [11], who reported similar findings. The combination of silica gel and river sand likely enhanced moisture absorption and provided a gentler drying environment, improving flower preservation compared to other treatments.

Flower texture

The study assessed the effect of different desiccants on the texture of helichrysum flowers. among the treatments (T_1) embedding the flowers in silica gel resulted in the best texture with a score of 8.08, indicating superior preservation of texture. this was closely followed by the combination of silica gel and river sand (T_{10}), which recorded a score of 7.81. the flowers dried in silica gel recorded maximum score for retention of good texture, this might be due to optimum moisture retention by the flowers dried at fully opened stage with silica gel as desiccant, the result is in conformity with the finding of Patil (2003) [8] in carnation. The lowest scores 4.47 for texture were observed in embedding in vermiculite, this might be due to its loose and fine nature when does not provide the same level of structural support for the flowers as silica gel or river sand. as the flowers dry in Vermiculite they may lose their shape more easily due to the lack of firm supportive embedding, causing them to wrinkle or collapse.

Brittleness

Significant differences in brittleness were observed across the dried Helichrysum flowers. The highest brittleness score (7.29) was recorded in T_1 (silica gel), followed by T_{10} (silica gel + river sand 1:1) with a score of 6.92. The lowest score (5.04) was observed in T_3 (river sand). Silica gel (T_1) was the most effective desiccant, likely due to its high moisture-absorption capacity and efficient drying. It creates a low-humidity microenvironment around the flowers, rapidly removing moisture while preserving their structure and colour. this fast drying reduces shrinkage, but may increase brittleness slightly. Despite this, its overall efficiency in preserving flower quality makes it the best option. On the other hand, river sand (T_3) showed lower brittleness due to its slower drying rate and lower moisture absorption capacity. This resulted in longer moisture retention, causing uneven drying and tissue breakdown, which contributed to the lower brittleness score. Additionally, the rough texture of river sand can physically damage delicate flower tissues, further affecting their structural integrity.

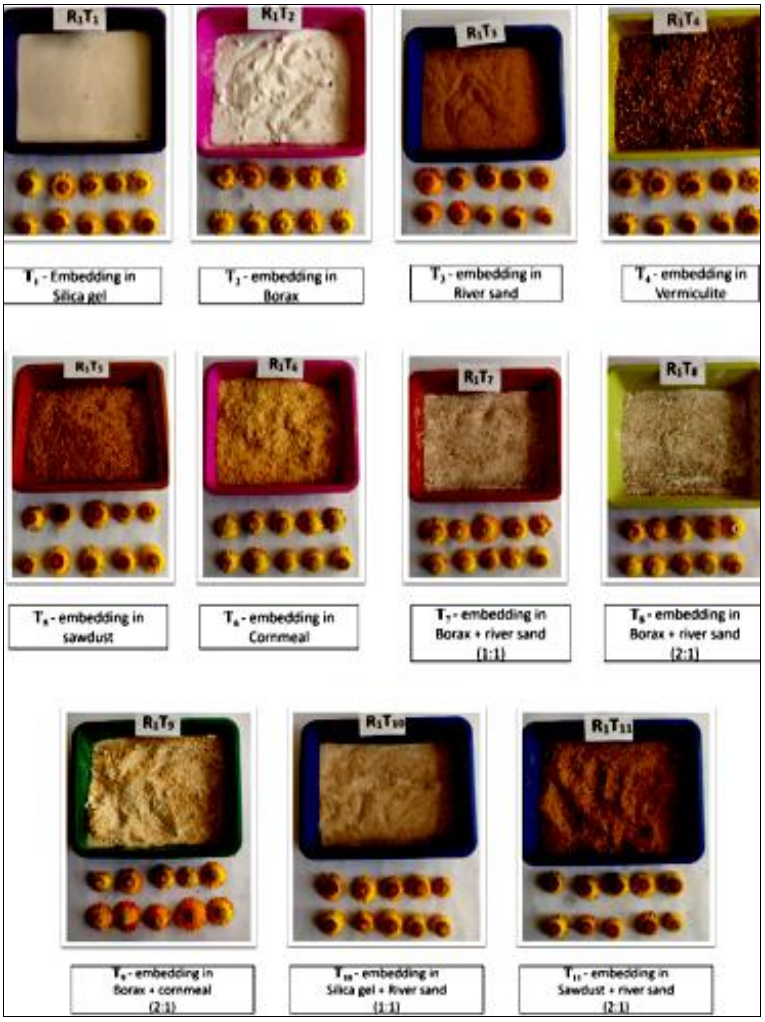

Plate 2: Comparison of best treatments

Table 2: Effect of different desiccants on Appearance, Texture and Brittleness of Helichrysum flowers

Tr. No.	Treatment	Flower appearance	Flower texture	Brittleness
T_1	Embedding in silica gel	8.02	8.08	7.29
T_2	Embedding in borax	6.41	7.73	6.18
T_3	Embedding in river sand	4.70	6.46	5.04
T_4	Embedding in vermiculite	5.38	4.47	5.59
T_5	Embedding in sawdust	5.11	5.18	5.74
T_6	Embedding in cornmeal	5.74	5.93	5.83
T_7	Embedding in borax + river sand (1:1)	6.04	6.17	6.17
T_8	Embedding in borax + river sand (2:1)	6.26	6.19	5.80
T_9	Embedding in borax + cornmeal (2:1)	5.86	5.71	6.06
T_{10}	Embedding in silica gel + river sand (1:1)	7.91	7.81	6.92
T_{11}	Embedding in sawdust + River sand (2:1)	6.15	5.26	5.62
	S.Em ±	0.05	0.05	0.03
	CD at 5%	0.15	0.17	0.10

Conclusion

Drying of helichrysum flowers with silica gel (T_1) followed by (T_{10}) silica gel + sand (1:1) as embedding media provided acceptable quality dried flowers. The result revealed that drying of helichrysum flowers with silica gel (T_1) followed by (T_{10}) silica gel + sand (1:1) found significant results for all parameters such as dry weight, percent moisture loss, times taken for drying, texture, brittleness, appearance and colour over other treatments. However, T_{10} (Embedding in Silica gel + River sand in 1:1 ratio) emerged as the most economical alternative, with results comparable to T_1. it provided a significant cost advantage due to the partial replacement of silica gel with river sand. This makes T_{10} a practical choice for larger-scale applications or scenarios where cost-effectiveness is a priority. Thus it can be concluded that embedding of helichrysum flowers in silica gel (T_1) remains the standard for the highest quality results, but (T_{10}) embedding in silica gel + river sand (1:1) is recommended as the best economic treatment for drying Helichrysum flowers while maintaining satisfactory quality.

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