

## Studies on glycerine drying of common lady fern (*Athyrium filix-femina*)

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### ABSTRACT

An investigation was done in the Department of Horticulture, School of Agricultural Sciences and Rural Development, Medziphema, Nagaland University during 2021 to study the effect of glycerine on drying of common lady fern (*Athyrium filix-femina*). Results showed that immersion method ( $M_2$ ) of glycerine application recorded the maximum score for the texture (3.71), shape retention (3.88), brittleness (3.82) and overall acceptability (4.06) when compared to uptake method ( $M_1$ ) of glycerine application. Among the glycerine concentration, 25% glycerine scored maximum (4.41) for overall acceptability followed by 50% glycerine (4.34) and minimum score (3.39) was recorded in control (distilled water). From the findings, it may be concluded that the immersion method ( $M_2$ ) of glycerine application was better when compared to uptake method ( $M_1$ ) in terms of all qualitative and quantitative characters and 25% glycerine was the best among the different glycerine concentration for drying of cut foliage of common lady fern.

**Keywords:** Glycerine drying, application method, glycerine concentrations, cut foliage

### INTRODUCTION

Flowers are an integral part of man's life and the love for natural flowers will always remain an inherent instinct. In India, floriculture is emerging as a fast expanding industry and importance has been given to this sector due to its uses. Fresh flowers though attractive and appealing to the eyes, have a very short vase life. Also they are not only expensive but its availability is restricted to its specific season. Therefore, efforts are being made for substitution of fresh flowers and foliage and this where the role of dry flower technology comes to limelight. Dry flower industry is considered to be most promising area in floriculture sector and considered a boon to the economy of the country. Dry flowers are essential export item both in domestic and international market. Major dried flowers are exported to countries like UK, Russia, Japan, Australia, Europe, USA and Hong Kong (Perinban *et al.* 2014). In India, dry flower constitutes more than two-thirds of floricultural exports and West Bengal alone accounts for around 70% of the dry flower export (Sumana 2011). There are different techniques of drying ornamental plant parts *viz.* air drying, sun drying, microwave oven drying, embedded drying and freeze drying (Bhalla and Sharma 2002). Glycerinization treatment is the most

suitable method for drying of foliage. Preserving plant material with glycol or glycerol is called glycerinization. The objective is to maintain the suppleness of the plant material. There are two methods by which the plants can be preserved using glycerine *viz.* systemic or immersion method. Glycerine is a humectant that can be absorbed into plant tissue either by transpiration stream uptake or by immersing cut foliage in the solution and preserves foliage by replacing the natural moisture present in the leaf with glycol and maintains the leaf form, texture, colour (Bale 2006) and more natural in appearance (Leonard 1973). The processed part looks more natural than air dried leaves and ultimately, glycerine-preserved foliage has a soft and leathery feel (White *et al.* 2007). Hence, the present investigation was undertaken to assess the effect of glycerine and its concentration levels for drying of common lady fern (*Athyrium filix-femina*).

### MATERIALS AND METHODS

The experiment was conducted in the laboratory, Department of Horticulture, School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema campus, Nagaland during 2021. The experiment was laid out in completely randomized design

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(factorial) with two methods of glycerine application *i.e.* uptake method ( $M_1$ ) and immersion method ( $M_2$ ) and 5 different glycerine concentration *i.e.* control (distilled water), 25% glycerine, 50% glycerine, 75% glycerine and 100% glycerine, replicated thrice for the cut foliage of common lady fern. The quantitative parameters were time taken for drying (days), change in leaf area (%), change in leaf weight (%), total volume uptake (ml) and the qualitative parameters were colour, texture, shape retention, brittleness and overall acceptance. Glycerol (glycerine) is a tri-hydric alcohol. It is a colorless, odorless, sweet tasting syrupy liquid and non-toxic. It melts at  $17.8^{\circ}\text{C}$ , boils with decomposition at  $290^{\circ}\text{C}$ , and is miscible with water and ethanol. The plant materials were collected from the wild within the campus area, SASRD, Medziphema. *Athyrium filix-femina*, the Common lady fern is a large, perennial upright feathery species of fern. The leaves are bright green, with a fine-textured lacy appearance and single fronds up to 1cm width and 3 cm in length. The leaves is said to be fully matured when the feathery texture of the foliage gives a rough hardy feel on touching and the tip of the fronds fully uncurls itself. The foliage which was fresh, healthy, disease free and uniform in size was harvested using a sterilized secateur. The dried product were observed and assessed by means of sensory evaluation.

## RESULTS AND DISCUSSION

### Quantitative parameters

Data presented in Table 1 show the effect of different methods of application and concentrations of glycerine on time taken for drying on cut foliage of common lady fern (*Athyrium filix-femina*). The leaves which were treated with 100% glycerine solution recorded minimum time for drying of foliage (1.38 days) whereas maximum time for drying of foliage (3.27 days) was recorded when the leaves were kept in control (distilled water). In uptake method, foliage kept under control took maximum days (2.94 days) for drying while minimum (1.33 days) was recorded in 100% glycerine. Similar results were obtained in foliage treated by immersion method where maximum (3.60 days) and minimum (1.44 days) time taken for drying foliage was noted in control and glycerine 100%, respectively. It is observed from the result that the foliage treated with glycerine underwent faster drying process as compared to water drying Yadav (2017) and plant material take few days to week for drying, Westland (1995). The results were significant for glycerine concentration and its method of application while it showed non-significant results for its interactions.

Table 1: Effect of different methods of application and concentrations of glycerine on quantitative characters of cut foliage of common lady fern (*Athyrium filix-femina*)

Glycerine concentration (C)	Time taken for drying (days)			Change in leaf area (%)			Change in leaf weight (%)			Total volume uptake (ml)		
	$M_1$	$M_2$	Mean	$M_1$	$M_2$	Mean	$M_1$	$M_2$	Mean	$M_1$	$M_2$	Mean
Control(distilled water)	2.94	3.60	3.27	90.10*	102.31	2.12	2.54*	2.67	2.60	13.2	19.99	16.60
25% glycerine	2.27	2.94	2.60	(2.34)**	(1.90)	1.79	(22.97)**	(22.95)	(22.96)	2	3.55	13.66
50% glycerine	2.10	2.49	2.30	109.57	87.02	1.69	2.83	2.55	2.69	1.79	2.14	1.96
75% glycerine	1.55	1.77	1.66	(2.12)	(1.47)	1.64	(13.82)	(11.63)	(12.72)	1.58	1.86	1.72
100% glycerine	1.33	1.44	1.38	108.43	98.70	1.51	2.80(-)	2.36 (-)	2.58	0.65	1.12	0.88
Mean	2.04	2.45	2.09	(2.09)	(1.30)	6.05	8.71)	10.85)	(-9.78)	4.15	7.75	
CD ( $p = 0.05$ )	M	: 0.04	M	: 0.34	M	: NS	9.39)	11.70)	(-10.54)	M	: 0.15	
	C	: 0.10	C	: NS	C	: 1.85	3.04 (-)	2.35 (-)	2.69	C	: 0.38	
	C X M	: NS	C X M	: NS	C X M	: NS	12.64)	13.21)	(-12.92)	C X M	: 0.76	

$M_1$  – Uptake method,  $M_2$  – Immersion method

Data presented in Table 1 revealed that maximum change in leaf area (2.09%) was noted in uptake method while, it was minimum (1.41%) in immersion method. Mean results presented in the table has shown that there was a least change in leaf area (1.51%) at 100% glycerine concentration and the leaves that were kept under control (distilled water) showed a maximum change in leaf area (2.12%). Similar results were obtained in uptake method and immersion method where minimum change in leaf area (1.87% and 1.16%, respectively) was observed at a concentration of 100% glycerine; while maximum change (2.34% and 1.90%, respectively) was recorded from control (distilled water). In a similar study by Yadav *et al.* (2018) it was noticed that leaves treated with higher concentration of glycerine has less water loss and high membrane integrity which may result in minimum change in leaf area of the cut foliage. Similarly, high transpirational loss resulted in shrinkage of leaf tissue which may be the reason for maximum change in leaf area which was treated in control (distilled water). Vicre *et al.* (2004) similarly reported that as leaves undergoes transpirational loss the cellular pressure decreases which results in separation of cell membrane from the cell wall subsequently reaching a point leading to shrinkage of the leaf, Kramer and Boyer (1995). According to Vasfilov (2011), it was reported that under conditions of water deficiency leaf mass area may increase at the expense of starch accumulation, which supports the present findings where minimum change in leaf area is recorded in leaves treated with glycerine solution.

The data presented in the Table 1 displayed that cut foliage treated with 100% glycerine recorded maximum weight gain (-12.92%) which was found at par with 75% glycerine (-10.54%), whereas the foliage kept in control (distilled water) showed maximum weight loss (22.96%) which was at par with 25% glycerine (12.72%). In both the methods, the cut foliage which were treated with 100% glycerine recorded the highest weight gain (-12.64% and -13.21%, respectively) and maximum weight loss (22.97% and 22.95%, respectively) was observed in control (distilled water). The results are in accordance with the findings of Yadav *et al.* (2018) who reported that cut foliage treated with high concentration of glycerine absorbs higher glycerine solution when compared to different glycerine concentration and water.

Glycerol treatment reduces plant water loss by reducing the transpiration rate (Nermeen and Shanani, 2011) thus, supports the present findings where greater change in leaf weight is seen best in cut foliage treated with pure glycerine by minimizing the water loss and increasing the moisture content by high glycerine uptake.

The perusal of the data in the Table 1 showed that the cut foliage treated in immersion method ( $M_2$ ) of glycerine application resulted in highest uptake of the volume (7.75 ml) when compared to uptake method ( $M_1$ ) of glycerine application *i.e.* (4.15 ml). Maximum volume uptake (16.60 ml) was in control (distilled water) and treatment with 100% glycerine recorded the minimum (0.88 ml) volume uptake. In the uptake method of glycerine application ( $M_1$ ), maximum (13.22 ml) and minimum (0.65 ml) volume uptake was seen in control (distilled water) and 100% glycerine treatment respectively. Similarly, in the immersion method of glycerine application ( $M_2$ ), maximum volume uptake (19.99 ml) was seen in cut foliage treated in distilled water and minimum volume uptake (1.12 ml) was observed in cut foliage treated with 100% glycerine. Data showed that treatment with higher concentration of glycerine significantly reduced volume uptake owing to its viscosity and glycerine uptake was increased with the increase of extended absorption duration (Malakar *et al.* 2016). Also, measurable respiration with metabolic functions ceased within 1.5 days of commencing treatment (Campbell *et al.* 2000).

The colour of the dried foliage was carefully analyzed and recorded as per the colour chart of Royal Horticulture Society. As evident from the data presented in the Table 2, the colour of fresh foliage falls in Green group (143 B) of RHS colour chart and all the treated and dried cut foliage varied in colour retention. As per the observations recorded from the RHS colour chart, it revealed that the colour of the dried foliages falls to a certain natural (Green group 144 B) for both the method of glycerine application in control treatment (distilled water). The method of glycerine application did not influence the colour of the foliage. Colour of the dried leaves showed a darker greener shade (Green group 146 B) treated with glycerine at 25%, 50% and 75% concentrations; while the colour of the dried leaves treated in 100% glycerine concentration was rustic yellowish (Olive Green Group 152 B).

Table 2: Effect of glycerine application and concentrations of glycerine on colour of cut foliage of common lady fern (*Athyrium filix-femina*)

Glycerine concentration (C)	Before	After	
		M <sub>1</sub>	M <sub>2</sub>
Control (distilled water)	Green group 143B	Green group 144 A	Green group 144 A
25% Glycerine	Green group 143B	Green group 146 B	Green group 146 B
50% Glycerine	Green group 143B	Green group 146 B	Green group 146 B
75% Glycerine	Green group 143B	Green group 146 B	Green group 146 B
100% Glycerine	Green group 143B	Olive Green group 152 B	Olive Green group 152 B

M<sub>1</sub> – Uptake method, M<sub>2</sub> – Immersion method

### Qualitative parameters

Table 3 shows that immersion method (M<sub>2</sub>) is the best as compared to uptake method (M<sub>1</sub>) in terms of quality parameters like texture (3.71 and 3.57 respectively), shape retention (3.88 and 3.56 respectively), brittleness (3.82 and 3.73 respectively) and overall acceptance (4.06 and 3.86 respectively). Data further showed that foliage treated in 25% glycerine scored maximum (3.98, 4.09, 4.22 and 4.41 respectively) for texture, shape retention, brittleness and overall acceptance. The minimum score was observed on texture (3.11), shape retention (3.43), brittleness (3.25) and overall acceptance (3.39) in distilled water. In uptake method, 25% glycerine recorded the highest score on texture (3.86), shape retention (3.88), brittleness (4.14) and overall acceptance (4.25) and control (distilled water) recorded the lowest score on texture (3.07), shape retention (3.44), brittleness (3.35) and overall acceptance (3.35).

Similarly, in immersion method, 25% glycerine recorded the highest score on texture (4.09), shape retention (4.31), brittleness (4.29) and overall acceptance (4.57) and control (distilled water) recorded the lowest score on texture (3.15), shape retention (3.42), brittleness (3.16) and overall acceptance (3.44). Cut foliage fully immersed in glycol solution resulted in better preservation attributes with more natural appearance and pliability (Sheldon and Sheldon 1975). On treating the cut foliage with different and high concentrations of glycerine, the leaves absorb enough liquid and look smooth, glossy and have good flexibility. This was in conformity with the findings of (Day 2000), White *et al.* (2007) who reported that glycerinisation holds good for foliage and results in better acceptability of qualitative parameters. Treating the plant material with glycerine enables it to retain its originality in qualitative attributes and improving flexibility less prone to shattering and mechanical damage (Leonard 1973).

Table 3: Sensory evaluation for qualitative parameters of cut foliage of common lady fern (*Athyrium filix-femina*) under different methods of glycerine application and concentrations of glycerine

Glycerine concentration (C)	Texture (5)			Shape retention (5)			Brittleness (5)			Overall acceptance (5)		
	Method of glycerine application (M)											
	M <sub>1</sub>	M <sub>2</sub>	Mean	M <sub>1</sub>	M <sub>2</sub>	Mean	M <sub>1</sub>	M <sub>2</sub>	Mean	M <sub>1</sub>	M <sub>2</sub>	Mean
Control (distilled water)	3.07	3.15	3.11	3.44	3.42	3.43	3.35	3.16	3.25	3.35	3.44	3.39
25% glycerine	3.86	4.09	3.98	3.88	4.31	4.09	4.14	4.29	4.22	4.25	4.57	4.41
50% glycerine	3.82	4.04	3.93	3.46	4.14	3.80	4.01	4.24	4.13	4.15	4.52	4.34
75% glycerine	3.65	3.73	3.69	3.53	3.65	3.59	3.57	3.76	3.67	3.83	3.96	3.89
100% glycerine	3.49	3.54	3.51	3.53	3.71	3.62	3.58	3.66	3.62	3.73	3.85	3.79
Mean	3.57	3.71		3.56	3.88		3.73	3.82		3.86	4.06	
CD ( $p = 0.05$ )	M : NS			M : 0.06			M : NS			M : 0.03		
	C : 0.10			C : 0.17			C : 0.09			C : 0.07		
	C X M : NS			C X M : NS			C X M : NS			C X M : NS		

M<sub>1</sub> = Uptake method M<sub>2</sub> = Immersion method

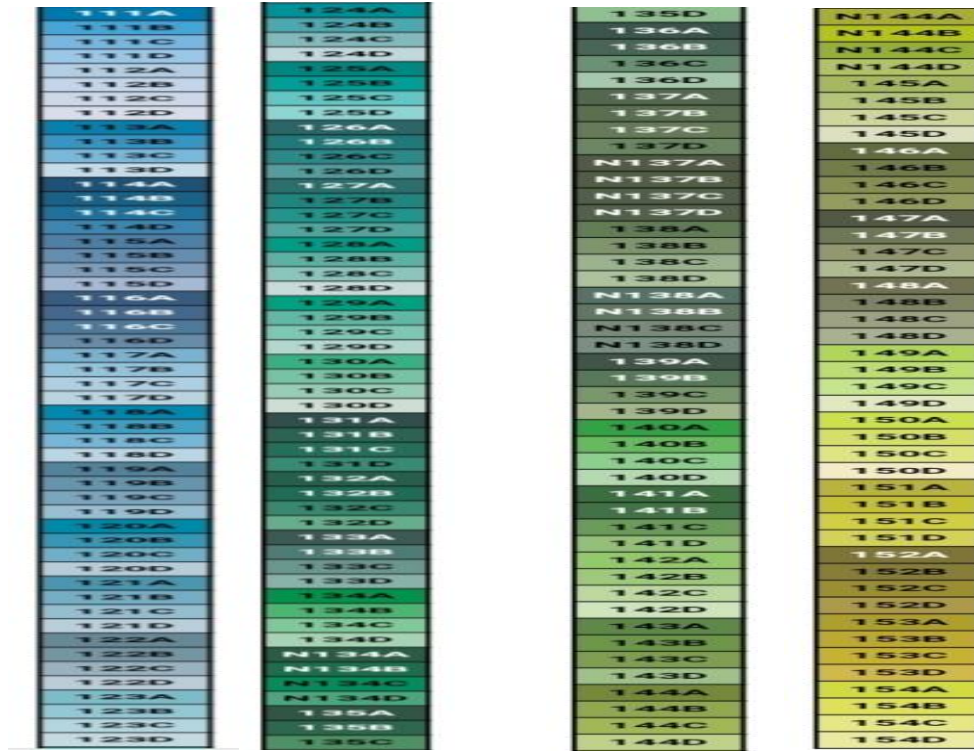


Plate 1: Royal Horticultural Society (RHS) colour chart

From the above findings, it has been concluded that the immersion method ( $M_2$ ) of glycerine application was better when compared to uptake method ( $M_1$ ) in terms of all qualitative

and quantitative characters and 25% glycerine was the best among the different glycerine concentration for drying of cut foliage of common lady fern.

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