International Journal of Farm Sciences **8(3):** 51-57, 2018; doi: 10.5958/2250-0499.2018.00081.2

Effect of glycerine on drying of cut foliage of *Polystichum squarrosum* (D Don) Fee

PRIYA YADAV, BHARATI KASHYAP, SR DHIMAN, PUJA SHARMA, YC GUPTA and MEENAKSHI SHARMA

Department of Floriculture and Landscape Architecture
Dr YS Parmar University of Horticulture and Forestry
Nauni, Solan 173230 Himachal Pradesh, India
Email for correspondence: priyayadav131093@gmail.com

 Received: 13.12.2017/Accepted: 21.4.2018

ABSTRACT

Preserving plant material with glycol is called glycerinisation which helps to retain its original texture, shape and colour. Leaves preserved through glycerine are less prone to shattering and mechanical damage and more natural in appearance. The study was carried out to assess the effect of glycerine for drying of cut foliage of a western Himalayan native fern *Polystichum squarrosum* by two methods (uptake and full-dip) with different concentrations of glycerine (10, 20 and 40%). Scores on quality parameters like textural quality (4.89), shape retention (4.89), brittleness (5.00) and overall acceptance (4.92) were maximum when the leaves were treated with 40 per cent glycerine solution by full-dip method. The same percentage of glycerine solution also resulted in gain in leaf weight, minimum change in leaf area and low leachate percentage.

Keywords: *Polystichum squarrosum;* glycerinisation; uptake method; full-dip method; quality parameters

INTRODUCTION

Dry flowers and plant material have great potential as a substitute for fresh flowers and foliage. The beauty and value of the dried flowers are that these can be kept and cherished for a longer period and therefore known as everlastings. The life of dried flowers varies according to the species, texture of their petals and total consistency of flowers. Dried flowers can be effectively used for making decorative floral craft items for interior decoration and commercial exploitation. Dry flowers have good demand both in domestic and international markets. From India these are being exported to countries like Japan, Europe and USA. India is the fifth largest exporter of dried flowers and the industry exports 500 varieties of flowers from India to 20 countries. India is one of the major exporters of dried flowers to the tune of 5 per cent world trade in dry flowers. This industry shows a growth rate of 15 per cent annually. Today plant materials available commercially as well as those preserved with modern methods are almost unbelievably fresh-looking and represent a wide range of colours. Glycerine drying is the most suitable method for drying of foliage as it gives the materials more flexibility with low brittleness and good overall acceptance (Anitha 2010). Preserving plant material with glycol is called glycerinisation. In this technique the internal moisture of plant parts is replaced with solvents like glycol to retain their original texture, shape and colour. The processed parts look more natural than air-dried leaves (White et al 2007). Leaves preserved through glycerine are less prone to shattering and mechanical damage and more natural in appearance (Leonard 1973). In the study *Polystichum squarrosum* (Plate 1a), a native fern (family Dryopteridaceae) was used. *Polystichum* species are terrestrial or rock-dwelling ferns of warm-temperate and montane-tropical regions (a few species grow in alpine regions). This fern contains dark green, leathery and shiny fronds which are valued in flower arrangements for their elegance and long-lasting nature. The leaves have commercial importance in flower trade and are extensively used for decoration in marriages, pandals, temples etc. It is commonly sold by the name Pahadi

Patti in the florists' shops. The present study was carried out seeing the importance of cut foliage in preparing various dry flower products such as dry flower arrangements, bouquets etc.

MATERIAL and METHODS

The investigations were done in a completely randomized design (factorial) in the Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during the year 2016-17. The climate of the area is typically sub-temperate. Leaves of *P squarrosum* were harvested from the plants at mature stage and a sample size of 15 cm long leaf was taken for preservation. The leaves were treated in glycerine solution by two methods viz uptake and full-dip at different concentrations such as 0, 10, 20 and 40 per cent. To avoid any fungal and bacterial infection on the treated leaves during the experiment carbendazim (0.1%), mancozeb (0.25%) and streptocycline (0.1%) were added to the treatment solutions. The observations on change in leaf weight (Ranganna 1977), change in leaf area, membrane integrity (Leopold et al 1981), chlorophyll content (Yoshida et al 1971) and quality parameters like texture and brittleness (Peryam and Pilgrim 1957), shape retention and overall acceptance (Vishnupriya 2011) were assessed by means of sensory evaluation by scoring on five-point scale viz excellent, good, moderate, poor and very poor. The data were subjected to statistical analysis adopting the standard procedure as laid down by Panse and Sukhatme (2000).

RESULTS and DISCUSSION

Data presented in Table 1 show the effect of different methods of application and concentrations of glycerine on change in leaf weight of cut foliage of *P squarrosum*. The foliage treated by full-dip method of glycerine application (M_2) gained weight (-0.44%) and treated by uptake method (M_1) lost the weight (15.35%). The foliage treated with 40 per cent glycerine (T_4) produced best results with maximum weight gain (-12.47%) which was found at par with 20 per cent glycerine (1.16%). In contrast the foliage kept in distilled water (T_1) showed maximum loss in weight (24.04%) which was at par with T_2 (17.08%). In both the methods leaves in T_4 were the best with highest weight gain (-1.06 and -23.89% respectively) whereas maximum weight loss was observed in control. The leaves treated with high concentration of glycerine absorbed higher amount of glycerine as compared to other concentrations of glycerine and water therefore there might have been greater change in weight of the leaves due to high uptake and moisture content. Glycerine replaces the moisture by capillary action when leaves are placed in uptake method whereas through the surface of the leaves when these are fully dipped (White et al 2007).

Data presented in Table 1 also show that change in leaf area in full-dip method (M_2) was less (2.87%) as compared to uptake method (M_1) ie 3.99 per cent. Data further show that T_4 exhibited the best results with minimum change in leaf area (1.29%) and the maximum change in leaf area (5.52%) was recorded in the leaves which were kept in distilled water. In uptake method T_4 showed minimum change in leaf area (1.32%) whereas the foliage recorded maximum change in leaf area (6.27%) in distilled water. In full-dip method change in leaf area was minimum (1.27%) when treated with 40 per cent glycerine solution and maximum change in leaf area (4.77%) was recorded in control. As leaves lose water the cellular turgor pressure decreases and the cell membrane separates from the cell wall (Vicre et al 2004). After a critical point is reached the cell wall collapses resulting in deformations, folds and subsequent shrinkage of the leaf (Kramer and Boyer 1995). High dehydration leads to shrinkage of leaf tissue which may be the reason for maximum change in leaf area in the leaves which were kept in distilled water. Simultaneous replacement of water loss with uptake of glycerine in tissues resulted in less change in leaf area in leaves treated with glycerine.

The foliage treated with glycerine through uptake method showed better membrane integrity as compared to full-dip method (89.41 and 90.48% respectively). The foliage treated in T_4 gave the best results with low leachate (84.07%) which gives better membrane integrity. In contrast the foliage in distilled water showed maximum leachate (93.95%). In both the methods among leaves treated with 40 per cent glycerine were found best with low leachate (84.21 and 83.93% respectively) whereas leaves in control recorded more leachate (92.88 and 95.02% respectively). Maximum leachate in leaves with higher moisture loss is due to maximum cell injury (Bajji et al 2001). The leakage is due to damage to cell membranes which becomes more permeable under water loss condition (Senaratna and McKersie 1983). The increased permeability leads to more leakage of ions (Surendar et al 2013).

Table 1. Effect of different methods of application and concentrations of glycerine on change in leaf weight, leaf area and leachate of cut foliage of *Polystichum squarrosum*

Treatment	Glycerine concentration (%) (C)	Effect of different treatments under two methods of application (M)								
		Change in leaf weight (g)			Change in leaf area (cm^2)			Percentage of leachate		
		M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
T_1	0 (distilled water)	1.33* (26.62)	0.85 (21.46)	1.09 (24.04)	74.97* (6.27)	68.02 (4.77)	71.49 (5.52)	92.88*	95.02	93.95
T_2	10	1.08 (22.62)	0.69 (11.54)	0.88 (17.08)	71.89 (5.56)	74.42 (4.05)	73.15 (4.81)	90.58	92.37	91.47
T_3	20	1.12 (13.22)	0.89 (-10.90)	1.01 (1.16)	71.20 (2.82)	73.16 (1.37)	72.18 (2.10)	89.96	90.57	90.26
T_4	40	1.37 (-1.06)	0.95 (-23.89)	1.16 (-12.47)	76.72 (1.32)	79.90 (1.27)	78.31 (1.29)	84.21	83.93	84.07
Mean	-	1.22 (15.35)	0.85 (-0.44)	-	73.69 (3.99)	73.87 (2.87)	-	89.41	90.48	-

M_1= Uptake method, M_2= Full-dip method, Figures in the parentheses are per cent values, *Initial leaf weight/leaf area

$CD_{0.05}$	Change in leaf weight	Change in leaf area	Leachate
M	10.51	0.40	0.71
C	14.87	0.59	1.00
M x C	NS	0.80	NS

Data in Table 2 show that there was no effect of method of application on the chlorophyll content of leaves. The leaves treated with 20 per cent solution had high chlorophyll a (1.68 mg/g) content which was at par with T_2 (1.48 mg/g). T_4 showed higher chlorophyll b (4.61 mg/g) followed by T_3 (3.95 mg/g) whereas total chlorophyll was 3.87, 3.83 and 4.00 mg/g in T_2, T_3 and T_4 respectively the three being at par but significantly higher than control (2.83 mg/g). Maximum chlorophyll a content (1.83 mg/g) was recorded under full-dip method when leaves were treated with 20 per cent glycerine and maximum chlorophyll b (4.89 mg/g) and total chlorophyll (4.89 mg/g) content was recorded in 40.00 per cent glycerine treatment under full-dip method. Chlorophyll content of leaves may vary according to the leaf age. The addition of glycerol increases the rate of degradation of chlorophyll (Lajolo and Marquez 1982) in leaves. The chlorophyll being an oily pigment, minimum change in concentration might be due to minimum water loss whereas the low chlorophyll content in leaves treated with glycerine might be due to higher dehydration.

Table 3 shows that full-dip method (M_2) is the best (Plates 1b, 1c) as compared to uptake method (M_1) in terms of quality parameters like texture (3.89 and 3.05 respectively), shape retention (4.22 and 2.75 respectively), brittleness (3.66 and 2.69 respectively) and overall acceptance (3.92 and 2.83 respectively). Data further show that foliage in T_4 scored maximum for texture, shape retention, brittleness and overall acceptance with sensory scores 4.61, 4.00, 4.55 and 4.39 respectively. The minimum score was observed on texture (2.00), shape retention (2.83), brittleness (1.77) and overall acceptance (2.20) in distilled water. In uptake method T_4 recorded the highest score on texture (4.33), shape retention (3.11), brittleness (4.11) and overall acceptance (3.85) and T_1 recorded the lowest score on texture (1.89), brittleness (1.67) and overall acceptance (2.18) and leaves treated with 10 per cent glycerine recorded lowest score on shape retention (2.00). In full-dip method T_4 recorded the highest score on texture (4.89), shape retention (4.89), brittleness (5.00) and overall acceptance (4.92). In contrast minimum score on texture (2.11), shape retention (2.66), brittleness (1.89) and overall acceptance

Table 2. Effect of different methods of application and concentrations of glycerine on chlorophyll content of cut foliage of *Polystichum squarrosum*

Treatment	Glycerine concentration (%) (C)	Effect of different treatments under two methods of application (M)								
		Chlorophyll a (mg/g)			Chlorophyll b (mg/g)			Total chlorophyll (mg/g)		
		M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
T_1	0 (distilled water)	1.60	1.27	1.43	1.89	2.11	2.00	3.00	2.66	2.83
T_2	10	1.41	1.55	1.48	2.89	3.77	3.33	2.00	4.55	3.87
T_3	20	1.54	1.83	1.68	3.11	4.78	3.95	2.89	4.78	3.83
T_4	40	1.41	1.00	1.21	4.33	4.89	4.61	3.11	4.89	4.00
Mean	-	1.49	1.42	-	3.05	3.89	-	2.75	4.22	-

M_1= Uptake method, M_2= Full-dip method

$CD_{0.05}$

	Chlorophyll a	Chlorophyll b	Total chlorophyll
M	NS	NS	NS
C	0.20	0.34	0.31
M x C	0.27	0.49	0.44

Table 3. Sensory score (out of 5) (texture, shape retention, brittleness and overall acceptance) for foliage of *Polystichum squarrosum* under different methods of application and concentrations of glycerine

Treatment	Glycerin concentration (%) (C)	Effect of different treatments under two methods of application (M)											
		Texture			Shape retention			Brittleness			Overall acceptance		
		M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
T_1	0 (distilled water)	1.89	2.11	2.00	3.00	2.66	2.83	1.67	1.89	1.77	2.18	2.22	2.20
T_2	10	2.89	3.77	3.33	2.00	4.55	3.87	2.00	3.78	2.89	2.29	4.03	3.16
T_3	20	3.11	4.78	3.95	2.89	4.78	3.83	3.00	4.00	3.50	3.00	4.52	3.76
T_4	40	4.33	4.89	4.61	3.11	4.89	4.00	4.11	5.00	4.55	3.85	4.92	4.39
Mean	-	3.05	3.89	-	2.75	4.22	-	2.69	3.66	-	2.83	3.92	-

M_1= Uptake method, M_2= Full-dip method

$CD_{0.05}$

	Texture	Shape retention	Brittleness	Overall acceptance
M	0.16	0.17	0.15	0.09
C	0.22	0.24	0.21	0.13
M x C	0.31	0.33	0.29	0.18

(2.22) was recorded in control (T_1). Dried foliage was intact and pliable when treated with high concentration of glycerine. These findings are in equivalence with the earlier studies of Leonard (1973) who reported that glycerine-processed parts look more natural than air-dried leaves which are less prone to shattering and mechanical damage and more natural in appearance. Singh et al (2003) reported that moisture content in dried flowers influences flower quality and longevity. According to them excessive drying results in petal shedding during handling. This may be attributed to excessive loss of moisture which results in weakening of adhesion and cohesion forces in flower tissues which causes softening of middle lamella leading to abscission. The best result for brittleness was obtained when the leaves were treated with full-dip method. This observation is in line with the findings of Sheldon and Sheldon (1975) who reported that the cut greens immersed completely in preservation solution (glycol) gave more natural look and were more pliable and flexible than those of cut greens treated by dip method. Different types of value-added products like wall pictures, file covers, greeting cards and flower arrangements were prepared from dried leaves (Plate 2).

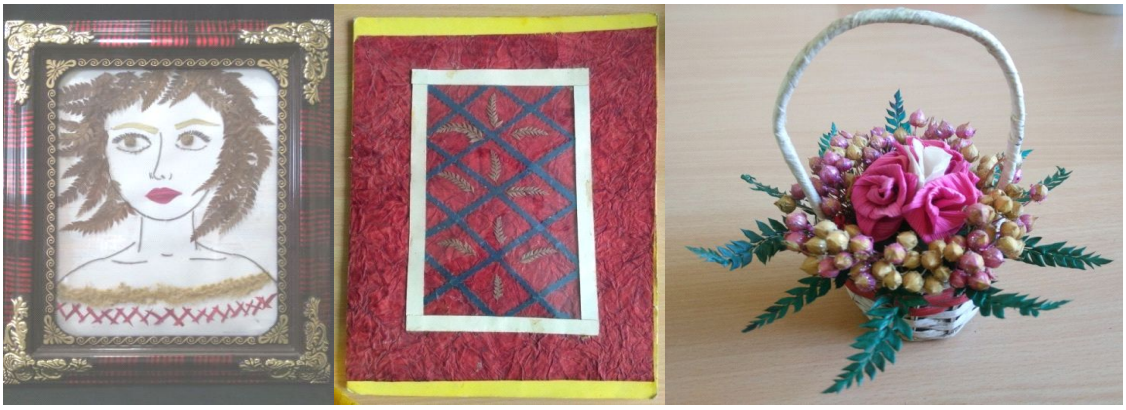
Plate 1a. *Polystichum squarrosum* plant

Control (distilled water) **10% glycerine** **20% glycerine** **40% glycerine**

Plate 1b. *Polystichum squarrosum* treated with uptake method

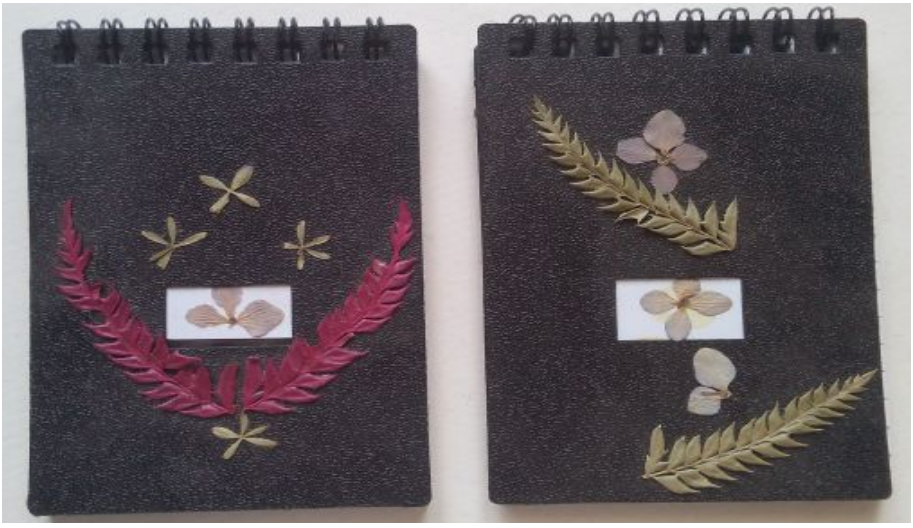
Control (distilled water) **10% glycerine** **20% glycerine** **40% glycerine**

Plate 1c. *Polystichum squarrosum* treated with full-dip method



Wall picture **File cover** **Flower arrangement**

Greeting cards



Notepad covers

Plate 2. Value-added products made from glycerine-dried leaves of *Polystichum squarrosum*

CONCLUSION

The results obtained from the present study revealed that full-dip method of glycerinisation is better as compared to uptake method and 40 per cent is the optimum concentration of glycerine for drying of cut foliage of *P squarrosum.*

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