



Conservation and Evaluation of Different Cut Foliage Species Comprising Pteridophytes (Ferns and Fern Allies) of West Coast Regions of India

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There is a great need to find cut foliage species suitable for use in floral displays for florists and floral designers. Cut foliages which stay green for long time, retain their appearance and which do not shed leaves or berries are desired characteristics for cut greens in floral displays. Ferns and *Asparagus* are popularly used in flower arrangements because of its year-round availability and good vase life. Ferns, apart from its use as a durable cut foliage crop for use in floral designs, also serve as a good ground cover for shady locations. It can also be planted in pots since potted ferns are commercially used in various landscape projects. Ferns, with their marvellous foliage and ample ecological adaptability, are of high significance in urban landscaping. Large scale collection of ferns from forests by visitors and local people for ornamental purpose, medicinal purpose and during excursions increases the pressure on these plants. Also, a large number of fern species is lost due to depletion of natural forest vegetation day by day. The vast potential in the west coast ecosystem like rich gene pool, natural habitat of many fern species, superiority of many of the species in terms of desirable foliage traits, suitable agro climatic conditions and fast growing domestic and export demand for cut foliages does not seem to be fully tapped. Hence conservation of biodiversity of these plants is the need of the hour. Extensive investigations were conducted during 2014-15 to trace and explore different cut foliage species comprising Pteridophytes (Ferns and fern allies) in the West Coast regions of India by the team of researchers at ICAR-Central Coastal Agricultural Research Institute, Goa. During the study, West Coast regions of India were visited, photographed and planting materials were collected and the locality was mapped using GPS technology. As an outcome of the botanical survey, 18 different cut foliage species comprising Pteridophytes (Ferns and fern allies) were collected, conserved and evaluated for their suitability for use as cut foliages or fillers. Significant variation was noticed among cut foliages used in the study for various morphological and leaf quality traits. Cut foliages like *Nephrolepis exaltata*, *Nephrolepis biserrata furcans*, *Nephrolepis cordifolia* 'Duffii' and 'Sprengeri' compacta are appropriate as fillers. *Pteris vittata* fronds can serve an ideal foundation for various arrangements. *Asparagus densiflorus sprengeri* can be used as cascading focal points in large designs and serves as excellent greenery in delicate flower bouquets. *Nephrolepis cordifolia* 'Duffii' and *Nephrolepis biserrata furcans* with their dense growth provides a vertical accent to floral designs. The commercial cultivation of these cut foliage species can serve as a highly profitable enterprise for improving the livelihood of farmers of West Coast regions. Results of this study reflect the aptness of different cut foliages to function for various purposes in floristry.

(**Key words:** *Cut foliages, Conservation, Ferns, Floristry, West coast*)

Ornamental filler crops assume a significant place in the domestic and international markets and it makes up an important section of floral industry as cut foliages. Cut foliages are used in large quantities for floral decoration either on its own or in association with flowers in bouquets and flower arrangements. They are gaining increasing popularity due to diversification of floriculture and lower cost of production compared to the traditional production of cut flowers. There is a great possibility

for exploitation of cut foliages because of year-round production, low investment and lesser risk. Ornamental filler crops are the basic and fundamental element of any floral arrangements and provide a glamorous touch to floral designs. The perishable decorative greens, which were used earlier at about 5 per cent as fillers in bouquet making have increased substantially to 20-25 per cent (Bhattacharjee, 2006). This trend has increased still further because of the green, lively and refreshing

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image presented by such products and the predicted increase in consumption of floral products. People usually prefer cut foliages which are striking in form, colour and freshness of leaves, substantive in texture with well-furnished sprays, resistant to wilting and long keeping quality in vase. There is always an enormous demand for excellent quality flower arrangements and bouquets. Here comes the importance of cut foliages, since they provide such originality. Cut foliages like *Asparagus* and ferns are excellent filler materials and are considered as highly valued florists' greens due to their graceful symmetry and lush green foliage. The vase life of florist greens should be on par with the cut flowers used in the floral displays. Ferns are considered as first true land plants and are among the world's oldest living plants. Plants in the genus *Asparagus* such as *A. setaceus* and *A. densiflorus* are called ferns, but they are not true ferns since they produce seeds and not spores. Due to ornamental nature of fern fronds and cladophylls of *Asparagus*, their potted plants find place in the terrace of houses, hotels, gardens, etc. Fern fronds are also used in bouquets and for decorating stages, halls, etc., during various functions (Dixit, 2000). Many nurseries grow ferns and sell them for a good price and these ferns are then used as ornamentals either as garden plants or during functions to beautify the place (Dudani *et al.*, 2011). Even though these filler plants are grown by many farmers, there is no scientific information on the choice, growth attributes and landscape performance. This supports the significance of conducting studies on cut foliages to meet the ever-growing demand in domestic and international markets. Flora of Western Ghats consists of about 12,000 species ranging from unicellular cyanobacteria to angiosperms. Amongst these the flowering plants constitutes about 27% of Indian flora with 4000 species of which about 1500 species are endemic. Apart from harboring a rich diversity of the angiospermic flora, Western Ghats are also a rich repository of cryptogams such as pteridophytes, bryophytes, lichens, fungi and algae. Western Ghats along with Himalayas, Eastern Ghats and parts of Central India forms a major centre for the distribution of the ferns and fern-allies (Dudani *et al.*, 2012). They grow luxuriantly in moist tropical and temperate forests and their occurrence in different eco-geographically threatened regions from sea level to the highest mountains are of much interest (Dixit, 2000). Large scale collection of ferns from forests by the visitors and local people for ornamental purpose,

medicinal purpose and during excursions also increases the pressure on these plants (Dudani *et al.*, 2012). Hence conservation of biodiversity of these ornamental plants is the need of the hour. With this background, a study on collection, conservation and evaluation of different cut foliages was conducted at ICAR - Central Coastal Agricultural Research Institute (CCARI), Goa with the objective to evaluate different cut foliages for their ornamental characteristics and to identify ornamental cut foliage crops that could be used for various purposes in floral industry.

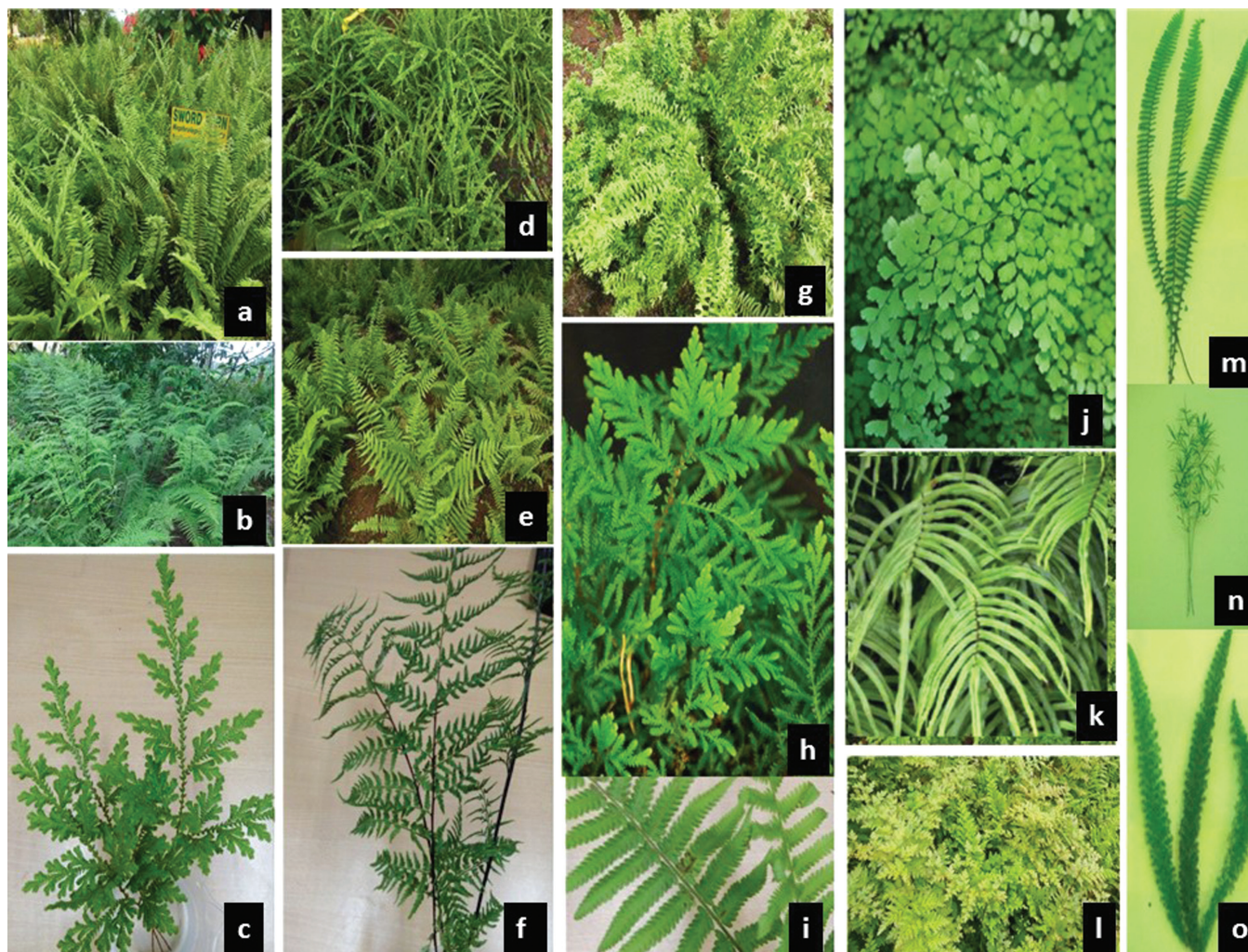
MATERIALS AND METHODS

Eighteen different types of cut foliage species comprising Pteridophytes (Ferns and fern allies) of West Coast regions of India were collected as an outcome of the botanical survey conducted during 2014-15. They were conserved and evaluated for their growth attributes, ornamental characteristics and vase life was carried out during 2015-2017. The different types of cut foliage species used in the present study include Boston fern (*Nephrolepis exaltata*), Bridal fern (*Asparagus setaceus* syn. *Plumosus*), Button fern (*Nephrolepis cordifolia* 'Duffii'), Compact *Sprengeri* fern (*Asparagus densiflorus* 'Sprengeri compacta'), Creeping fern/Wart fern (*Polypodium scolopendria*), Emerald fern (*Asparagus densiflorus* 'Sprengeri'), Fish tail fern (*Nephrolepis biserrata furcans*), Fox tail fern (*Asparagus densiflorus* 'Myers'), Hard fern (*Blechnum orientale*), Ladder brake fern (*Pteris vittata*), Leather leaf fern (*Rumohra adiantiformis*), Maiden hair fern (*Adiantum raddianum*), Oak-leaf fern (*Drynaria quercifolia*), Peacock fern (*Selaginella willdenowii*), Silverback fern (*Pityrogramma calomelanos*), Soft fern (*Christella dentata*), Staghorn club moss (*Lycopodiella cernua*) and Vine like fern (*Lygodium palmatum*). The different cut foliage species were assessed for their suitability for various purposes in floral industry. It was tested for various morphological growth parameters such as frond length, frond width, number of fronds per plant, number of leaflets per frond, frond production interval, fresh weight of the frond, stipe length, stipe girth as well as vase life. The experimental design adopted was randomized block design with three replications. Data recorded on various morphological parameters were statistically analyzed following procedures as described by Panse and Sukhatme (1978).

RESULTS AND DISCUSSIONS

Significant variation was noticed among the different cut foliage species used in the present study for various morphological and leaf quality traits and the data is presented in Table 1. The distinctive features of various cut foliage species conserved in the present study are discussed below and is illustrated in Fig. 1. Different cut foliage species showed significant differences with respect to frond length. Maximum frond length was noticed in *Lygodium palmatum* (250.0 cm) which was significantly superior to the other varieties under evaluation followed by *Nephrolepis exaltata* (90.4 cm). The least frond length (28.8 cm) was observed in

Adiantum capillus-veneris. *Nephrolepis exaltata* was observed to be an easy-to-grow fern with fast growth rate and produced great masses of long, narrow, green fronds, creating beautiful hanging baskets. Length of the frond has been pointed out as a character of prime importance in any cut foliage. The difference in frond length is a varietal trait as it is governed by the genetic make-up and also due to ideal environmental conditions. The carbohydrate storage in longer fronds is higher as compared to shorter fronds and it is probably the carbohydrate reserve in the fronds which helps in extending the keeping quality of cut foliages. Variations in frond length were due to varietal character which



a. *Nephrolepis exaltata*, b. *Pityrogramma calomelanos*, c. *Selaginella willdenowii*, d. *Nephrolepis scordifolia* 'Duffii', e. *Rumohra adiantiformis*, f. *Pityrogramma calomelanos*, g. *Nephrolepis biserrata furcans*, h. *Selaginella delicatula*, i. *Christella dentata*, j. *Adiantum raddianum*, k. *Pteris vittata*, l. *Selaginella willdenowii*, m. *Nephrolepis exaltata*, n. *Asparagus densiflorus* 'Sprengeri', o. *Asparagus densiflorus* 'Myers'

Fig 1. Variability observed in collection of cut foliages at ICAR –CCARI, Ela, Old Goa

Table 1. Plant growth characteristics of different cut foliage species under West Coast ecosystem

Treatments	Frond length (cm)	Frond width (cm)	No. of fronds per plant	No. of leaflets per frond	Frond production interval (days)	Fresh weight of the frond (g)	Stipe length (cm)	Stipe girth (cm)	Vase life (days)
<i>Nephrolepis exaltata</i>	90.40	8.20	72.00	53.40	3.00	4.68	4.16	0.64	11.40
<i>Nephrolepis cordifolia</i> 'Duffii'	82.64	0.72	99.83	272.30	3.40	11.33	6.73	0.82	6.40
<i>Polypodium scolopendria</i>	72.94	32.73	5.60	1.00	14.20	15.14	18.26	1.16	8.80
<i>Nephrolepis biserrata furcans</i>	85.60	13.72	49.20	52.40	5.20	6.75	8.40	1.02	3.80
<i>Blechnum orientale</i>	73.80	18.90	12.60	42.00	6.30	3.25	7.21	0.99	3.71
<i>Pteris vittata</i>	83.60	64.80	17.00	52.40	3.00	2.24	5.46	0.74	3.80
<i>Rumohra adiantiformis</i>	59.60	20.40	20.67	56.80	5.30	0.15	9.18	0.64	7.90
<i>Adiantum capillus-veneris</i>	28.80	3.72	9.20	22.40	4.21	2.70	6.40	0.12	3.80
<i>Drynaria quercifolia</i>	80.20	63.60	8.50	23.00	6.50	9.17	5.26	1.16	3.90
<i>Selaginella willdenowii</i>	41.00	17.40	23.00	17.20	11.02	2.65	5.50	0.12	1.10
<i>Pityrogramma calomelanos</i>	70.20	22.40	29.60	53.80	3.00	3.21	17.20	0.64	1.33
<i>Christella dentata</i>	57.10	12.40	19.60	58.80	5.30	6.40	8.12	0.54	2.30
<i>Selaginella delicatula</i>	43.50	11.90	3.60	11.40	12.20	8.54	2.16	0.44	3.50
<i>Lygodium palmatum</i>	250.00	10.72	1.20	15.24	5.60	2.56	7.40	1.02	1.80
<i>Asparagus setaceus</i> syn. <i>plumosus</i>	66.18	28.79	6.90	9.33	8.40	15.06	11.10	1.16	8.40
<i>A. densiflorus</i> 'Sprengeri' compacta	15.54	4.64	88.70	7.60	3.80	2.16	5.49	0.14	6.20
<i>Asparagus densiflorus</i> 'Sprengeri'	38.600	8.50	29.20	21.87	6.30	19.07	6.14	0.74	5.80
<i>Asparagus densiflorus</i> 'Myers'	58.79	3.69	10.40	161.80	12.10	25.04	1.72	1.66	11.20
SEm±	0.389	0.061	0.335	0.365	0.199	0.052	0.063	0.011	0.106
CD (P = 0.05)	1.167	0.182	1.004	1.095	0.599	0.157	0.189	0.033	0.318

was observed previously in ferns by Gilman (1999) and Oloyede and Odu (2011).

Throughout the experimental period, at all stages of growth, cut foliage species viz., *Pteris vittata*, *Drynaria quercifolia*, and *Polypodium scolopendria* produced maximum frond width of 64.80 cm, 63.60 cm, 32.73 cm, respectively. The minimum width of the fronds was observed in *Nephrolepis cordifolia* 'Duffii' (0.72 cm). Hence fronds of *Pteris vittata* and *Polypodium scolopendria* can serve as an ideal foundation for bouquets and can make a complementary backdrop to most floral designs because of its significantly higher frond width. Width of the fronds is one of the parameters that decide the significance of suitability of cut foliages for commercial cultivation. The variation among the cut foliages with regard to frond width could be due to the difference in the genetic make-up of the cultivars. This was in-line with the conclusions of Oloyede and Odu (2011) in ferns who observed wide variations among cultivars for frond width.

Significant differences were observed for number of fronds per plant among the different species of cut foliages under evaluation. Significantly higher number of fronds per plant was observed in *Nephrolepis cordifolia* 'Duffii' (99.83 nos.) which was followed by *A. densiflorus* 'Sprengeri' compacta, *Nephrolepis exaltata*, *Nephrolepis biserrata furcans* (88.70, 72.00 and 49.20 nos., respectively). The minimum number of fronds per plant of 1.20 nos. was recorded in *Lygodium palmatum*. From this result, it can be inferred that *A. densiflorus* 'Sprengeri compacta', *Nephrolepis exaltata* and *Nephrolepis biserrata furcans* can be used as ground covers because of its fast-growing nature. Number of fronds per plant is another important character which play a key role in deciding the ultimate yield of cut foliages. Variation in fern varieties with respect to number of fronds per plant might be due to the inherent genetic constitution of the variety.

Among the different species of cut foliages, the maximum number of leaflets per frond was noticed in *Nephrolepis cordifolia* 'Duffii' (272.30), *Asparagus densiflorus* 'Myers' (161.80) followed by *Christella dentata* (58.80), whereas minimum number of leaflets per frond was noticed in *Polypodium scolopendria* (1.00). *Nephrolepis cordifolia* produces short fronds which have numerous small leaflets along its stem

giving it a very exotic appearance. Its small light green rounded leaves on thin stems gives great textural interest for flower arrangements and provides a vertical accent to designs. *Asparagus densiflorus* 'Myers' with its beautiful arching cladode arrangement, cylindrical plume-like foliage and hue of pleasing light green makes it a charming filler to flatter sprays and cascade around any floral artwork. It is excellent for vertical accents in large arrangements and bends easily in creative shapes. The compactness and arrangement of leaflets in the fronds are two important characters which govern the price of the cut foliage.

Number of days taken for production of newer fronds differed significantly among the different cut foliage species. Significantly early production of fronds (3 days) was noticed in *Nephrolepis exaltata*, *Pteris vittata* and *Pityrogramma calomelanos* followed by *Nephrolepis cordifolia* 'Duffii'. Delayed production of fronds was observed in *Polypodium scolopendria* (14.20 days). The graceful fronds of these cut foliage species quickly spread over the ground by means of thin, green runners making them suitable as a splendid ground cover and for mass bedding on landscape schemes. Production of newer fronds is highly cultivar dependent. Being genetically controlled factor, the frond production interval varied among the different cut foliage species used in the study. Similar variations in time taken for newer frond production was reported previously by Yeh and Wang (2000), Strandberg (2003) and Oloyede and Odu (2011) and in ferns.

Among the different species of cut foliages, the maximum fresh weight of fern frond was noticed in *Asparagus densiflorus* 'Myers' (25.04 g), *Asparagus densiflorus* 'Sprengeri' (19.07 g), *Polypodium scolopendria* (15.14 g) followed by *Asparagus setaceus* syn. *Plumosus* (15.06 g), whereas minimum fresh weight was noticed in *Asparagus densiflorus* 'Sprengeri compacta' (2.16 g). This variation in fresh weight among cut foliages might be attributed to the higher water and carbohydrates level in the foliage. Water plays a key role in maintaining turgidity and freshness of the cut foliage. Genetic constitution of varieties influenced the fresh weight of the fronds in the present study. Such variations in fresh weight among the varieties was reported earlier by Stamps (2006) in *Asparagus retrofractus*.

In the present investigation, the different cut

foliages have shown significant differences with regard to length of the stipe. The stipe length was found significantly highest in *Polypodium scolopendria* (18.26 cm) followed by *Pityrogramma calomelanos* (17.20 cm). The lowest stipe length of 1.72 cm was found in *Asparagus densiflorus* 'Myers'. Longer stipe length is a desirable character in cut foliages. Length of the stipe plays an important role in making the cut fern foliages presentable.

Like other characters, the variation in stipe girth was also noticed among different species of cut foliages. The stipe girth was maximum in *Asparagus densiflorus* 'Myers' (1.66 cm) and was followed by *Polypodium scolopendria* (1.16 cm). Minimum stipe girth was recorded in *Selaginella willdenowii* (0.12 cm). It is very essential for cut foliages to possess a strong and sturdy stem of sufficient strength. Stipe girth determines the sturdiness of the cut foliages. This is a varietal trait as it is governed by the genetic makeup. Similar variation in stipe girth was reported earlier by Oloyede and Odu (2011) in ferns.

Vase life is one of the important traits which decide the economic value of cut foliages. In the present study, vase life was significantly influenced by different species of cut foliages. Data showed that maximum vase life was observed in variety *Nephrolepis exaltata* (11.40 days) followed by *Asparagus densiflorus* 'Myers' (11.20 days), *Polypodium scolopendria* (8.80 days) and *Asparagus setaceus* syn. *Plumosus* (8.40 days). Vase life was minimum in *Selaginella willdenowii* (1.10 days). Vase life of the cut foliage seems to be an inherent capacity of the cultivar. This variation between varieties with regard to vase life could also be due to differences in the genetic make-up of the cultivars. Similar variation for longevity in cut foliages was also reported previously by Stamps *et al.* (2005) in ornamental *Asparagus* species and cultivars. The present study recommends that the lush green glorious, charming and charismatic foliage of *Nephrolepis exaltata* can find use in various floral designs as fillers. Fluffy, cloud-like appearance, cylindrical plume-like foliage and a hue of pleasing light green colour of *Asparagus densiflorus* 'Myers' makes it a charming filler to flatter sprays and cascade around any floral artwork. It is excellent for vertical accents in large arrangements and bends easily in creative shapes. *Asparagus setaceus* syn. *Plumosus* can serve as an ideal foundation for presentation style bouquets and makes a

complementary backdrop to most other floral designs. It can also be used as cascading focal points in large designs and serves as an excellent greenery in delicate flower bouquets.

Cut foliages are a boon to worldwide foliage industry. Ferns and *Asparagus*, apart from its use as a durable cut foliage crop for use in floral designs, serves as a good ground cover for shady locations. They can also be grown as potted plants for both indoor and outdoor use. Biodiversity conservation in cut foliages is the need of hour and steps for conserving them both *in-situ* and *ex-situ* should be focused upon. The *ex-situ* conservation includes development of conservatories or botanical gardens, germplasm banks, DNA banks, seed banks and involves the use of techniques such as tissue culture, cryopreservation; incorporation of disease, pest and stress tolerance traits through genetic transformation and ecological restoration of rare plant species and their populations (Kapai *et al.*, 2010). As an outcome of the study we have established a conservatory including different species of cut foliages. Based on the present study, we have identified evaluated and conserved different species of cut foliages. They could be used for various purposes in floral designs, as filler, table center piece, bouquets, wedding decorations, corsages, boutonnieres, swag, funeral designs, decorative wreaths, garlands, dry flower arrangements and in various landscape projects. A multitude of variegation patterns in these cut foliages imparts infinite design possibilities in landscaping. Apart from offering amusing visual charm, these foliages can be used to cover empty vacant spots in an effective way and fill our surroundings with fresh air.

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