



## Drying and dehydration of native ornamental plants of Arunachal Pradesh and its value addition

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Wild and underutilized plant species, particularly ornamental flowers and foliage, can be converted into value added products using the drying and dehydration techniques. The present study has been carried out to explore the potential of wild ornamental plants of Arunachal Pradesh for the purpose of dry flower making. The plant parts were collected from different places viz., Pasighat, Bodak, Renging, Menchuka, Bomdilla, Tenga Valley, Yingkiang, etc. A total of 14 potential plant species has been identified for drying and dehydration without any loss in quality and appearance. The species identified included viz., *Pteridium aquilinum* (Eagle Fern/Western Bracken Fern), *Lycopodium clavatum* (Stag's Horn Clubmoss/Ground pine), *Nicandra physalodes* (Apple of Peru), *Scirpus cyperinus* (Wool grass), *Barleria cristata* (Phillipine violet), *Cortaderia selloana* (Pampas grass), *Anaphalis busua* (Tall pearly everlasting), *Miscanthus* spp. (Silver grass), lichens, *Phragmites* spp. (common reed grass), *Davallia bullata* (Rabbit foot fern), *Tillandsia* spp. (Spanish moss), *Elsholtzia cristata* (Crested late summer mint) and *Setaria parviflora* (Bristly foxtail). Maximum number of genera belongs to the family of Poaceae followed by Cyperaceae. Seed heads of *Cortaderia selloana*, *Miscanthus* spp., *Phragmites* spp., *Erioscirpus comosus*, *Scirpus cyperinus*, *Setaria parviflora*; leaves of *Pteridium aquilinum*, *Lycopodium clavatum*, *Davallia bullata*; fruits of *Nicandra physalodes*, *Elsholtzia cristata*; flower of *Anaphalis busua*; dried calyx of *Barleria cristata* and stem of *Tillandsia* spp. has also been used for drying and value addition. Value added products that were prepared included wall décor, greeting cards, photo frames, dried flower arrangements, table décor, bouquet, paper bags, buttoniere and corsage, etc. A cottage industry based on floral craft can become a new area for self-employment of rural youths and women through this creative occupation. The quest for searching new materials which can be utilized as dried flowers never ends and in fact is the demand of the hour

**Keyword:** Dry flowers, Dehydration, Native, Technology, Value addition, Wild

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Floriculture is one of the most promising fields of horticulture that has gained importance as a money spinner business in many parts of the world. Cut flower accounts for the maximum contribution in the world of floriculture trade. However, their shelf-life is restricted for few days which cannot be kept for a long time and is also coupled with availability of flowers only during specific months. Even till date, commercial flowers like rose, carnation, gerbera, tulip, chrysanthemum, etc. still continue to be in demand and dominate both in domestic and international flower trade. But these flowers have a limited shelf life and their beauty cannot be enjoyed for long. For flower enthusiasts or those who are

involved in the trade, there is always a thirst for new and novel products in the market. Preserving the flowers in their natural state and keeping the colours intact is a way by which one can enjoy its beauty for a long time. The demand for dried/preserved flowers is on the rise worldwide as people continue to look for 'something new' in the market. These flowers also have the added advantage in terms of its shelf life if maintained properly and kept under controlled conditions which would lessen their damage from humidity and other microbial activities.

India is one of the biggest exporters of dried flowers and ranks fifth in global flower trade, contributing about 5% to the world flower trade<sup>1</sup>. In domestic market, this industry alone contributes 70% of the total earnings in flower trade. This industry is

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projected to have a growth rate of 15% annually and trade worth around Rs. 150 crores<sup>2</sup>. Potpourris has a major contribution and share in this industry to the tune of Rs. 55 crore in India alone. In 2018-19, the export of dry flowers and total floricultural products recorded Rs. 522.48 crore and 571.38 crores, respectively (APEDA). In India, dried flower units are mostly concentrated in Tuticorin (Tamil Nadu) and Kolkata<sup>3</sup>.

The flower drying technique involves reducing moisture content of flowers to a point at which microbial activity and the ageing effect come to a standstill and biochemical changes are minimized, thereby cell structure, pigment level and flower shape are maintained and retained. Thus, dry flower products can be stored for longer periods without any loss in their appearance and decorative value<sup>4</sup>. Processing techniques, particularly drying and dehydration techniques, assume a great significance in determining the final quality of dry flower products. Removal of moisture while retaining the original shape, colour and texture of plant material is the goal of drying techniques. Not all the methods apply to all the products<sup>5</sup>. Therefore, optimizing suitable methods for preservation and post-harvest handling of dried materials is another essential requirement in this area.

In the present scenario where people are becoming more eco-conscious, the use of natural products has become a choice for decoration and various flower arrangements. There is a tremendous export potential for dried product industry in the countries where climate is extreme cold or extreme hot and arid<sup>6</sup>. There are beautiful flowers, grasses, sedges, ferns, foliage, flowers and flower skeletons, seeds, pods, nuts and fruits which can be dried, preserved and made into value added products. These are available in the wild and still yet to be explored for its ornamental values. Few of these plants have been used as cut flowers or as loose flowers. Thousands of wild plants have great economic and cultural importance and tremendous market potential throughout the world. There is an increasing interest throughout the world, in “neglected and underutilized crop species”. Considering the abundant diversity of flora in the state of Arunachal Pradesh, the present studies have been conducted to explore the potential of native ornamental plants as dried products for the purpose of value addition.

### Study area

Arunachal Pradesh, located in the North Eastern most part of India harbours a huge diversity of flora and fauna and is a part of the biodiversity hot spots under the Himalayan ranges. The region has diverse topographical location due to which it enjoys multi-climatic conditions such as humid subtropical climate, humid subtropical climate, subtropical highland oceanic climate, warm humid continental climate and sub-arctic climate. The elevation of the region ranges from 120 m on the edge of Assam to above 7000 m on its Northern part of the bordering China. Across the state, it is covered by wide green forest, deep river valley and beautiful plateaus. The state is a home to 26 major tribes and more than 100 sub tribes with diverse cultures and habitats. It is being considered as one of the last reserves of exceptional biodiversity, preserved by the indigenous communities. In addition, the recent geological history, especially the Himalayan orogeny played an important role in the speciation and evolution of groups inhabiting mountains streams.

### Materials and Methods

To popularize the dried flower industry and to exhibit the true value of local flora, the present investigations were carried out in the Department of Floriculture Laboratory, College of Horticulture & Forestry, Pasighat, Arunachal Pradesh. The plant specimens for dehydration have been collected from places like Pasighat, Bodak, Tenga Valley, Menchuka, Bomdila, Renging, Mariang, Damro, etc. The GPS co-ordinates of different locations have been presented in Table 1 and the plants were collected from a mere 131 m to as high as 3250 m altitude, indicating the diversity of flowers in the state. The best time for collection of dried flowers from various places is from October to January when the flowers are in bloom. Almost all the raw plant materials used are underexploited plants growing in their natural habitats like forests and hillocks. The stage of harvest was fixed based on the nature of crop growth and flower development. Half bloom stage flowers were selected for perfect drying as these flowers retain colour, shape and visual quality at its best. The dried flower products are generally of two types viz., naturally dried and artificially dried products. The naturally dried plant parts have been collected from the wild which includes species like *Nicandra physalodes*, *Barleria cristata*, *Cortadesia selloana*, *Anaphilis busua*, *Miscanthus* spp., *Lycopodium clavatum*, *Scirpus cyperinus*, *Cortaderia*

Table 1 — GPS co-ordinates of different locations of collected native plants

Name of the species	Nature	Collection area	District	GPS Co-ordinates		Altitude
				Latitude	Longitude	
<i>Pteridium aquilinum</i>	Wild	Tenga Valley	West Kameng	27°06'0"N	92°24'0"E	3250 m
<i>Lycopodium clavatum</i>	Wild	Tenga Valley	West Kameng	27°06'0"N	92°24'0"E	3250 m
		Mariang	Upper Siang	28.4865° N	95.2248° E	131 m
<i>Nicandra physalodes</i>	Wild	Tenga Valley	West Kameng	27°06'0"N	92°24'0"E	3250 m
<i>Scirpus cyperinus</i>	Wild	Mayodia	Lower Dibang Valley	28°24'20 N	95.9253° E	2655 m
<i>Barleria cristata</i>	Wild	CHF Campus, Pasighat	East Siang	28.0619° N	95.3260° E	153 m
<i>Cortaderi aselloana</i>	Wild	Bodak	East Siang	28.1413° N	95.2789° E	131 m
<i>Anaphilis busua</i>	Wild	Tenga Valley	West Kameng	27°06'0"N	92°24'0"E	3250 m
		Bomdilla	West Kameng	27°15'0.00" N	92°24'0.0" E	2415 m
		Menchuka	Shi-Yomi	28.6001° N	94.1352° E	1829 m
<i>Miscanthus</i> spp.	Wild	CHF Campus, Pasighat, Bodak	East Siang	28.0619° N	95.3260° E	153 m
		Renging		28.1413° N	95.2789° E	131 m
		Renging		28.1233° N	95.2761° E	200 m
<i>Phragmites</i> spp.	Wild	Bodak, Renging	East Siang	28.1413° N	95.2789° E	131 m
				28.1233° N	95.2761° E	200 m
<i>Davalli abullata</i>	Wild	Mariang	Upper Siang	28.4865° N	95.2248° E	131 m
<i>Tillandsia</i> spp.	Wild	Tenga Valley	West Kameng	27°06'0"N	92°24'0"E	3250 m
<i>Erioscirpus comosus</i>	Wild	Bodak	East Siang	28.1413° N	95.2789° E	131 m
<i>Elsholtzia cristata</i>	Wild	Tenga Valley	West Kameng	27°06'0"N	92°24'0"E	3250 m
<i>Setaria parviflora</i>	Wild	CHF Campus, Pasighat, Bodak	East Siang	28.0619° N	95.3260° E	153 m
				28.1413° N	95.2789° E	131 m

Table 2 — List of native plants collected suitable for drying

Common Name	Scientific Name	Family	Parts suitable
Eagle Fern/Western Bracken Fern	<i>Pteridium aquilinum</i>	Dennstaedtiaceae	Leaf
Stag's Horn Clubmoss/Ground pine	<i>Lycopodium clavatum</i>	Lycopodiaceae	Leaf
Apple of Peru	<i>Nicandra physalodes</i>	Solanaceae	Fruits
Wool grass	<i>Scirpus cyperinus</i>	Cyperaceae	Seed head
Phillipine violet	<i>Barleria cristata</i>	Acanthaceae	Dried calyx
Pampas grass	<i>Cortaderia selloana</i>	Poaceae	Seed head
Tall pearly everlasting	<i>Anaphilis busua</i>	Asteraceae	Flower
Silver grass	<i>Miscanthus</i> spp.	Poaceae	Seed head
Common reed grass	<i>Phragmites</i> spp.	Poaceae	Seed head
Rabbit foot fern	<i>Davallia bullata</i>	Davalliaceae	Leaf
Spanish moss	<i>Tillandsia</i> spp.	Bromelliaceae	Stem
Hairy Cotton Grass	<i>Erioscirpus comosus</i>	Cyperaceae	Seed head
Crested late summer mint	<i>Elsholtzia cristata</i>	Lamiaceae	Fruit (Nutlets)
Bristly foxtail	<i>Setaria parviflora</i>	Poaceae	Seed head

*selloana*, *Erioscirpus comosus*, *Phragmites* spp., *Elsholtzia cristata* and *Setaria parviflora*. The plant parts are left to dry on the plant itself and is harvested when it is completely dried<sup>7</sup>. For ornamental ferns and foliage, press drying method was used. Only two species of plants viz., *Pteridium aquilinum* and *Davallia bullata* were dried through press drying which took about 14 days for proper drying. The best time for collection of the plants starts from October till January.

## Results and Discussion

A total of 14 species of plants were collected from the different districts of Arunachal Pradesh and the botanical names, common name, families and parts used for drying are presented in Table 2. The species identified includes *Pteridium aquilinum* (Eagle Fern/Western Bracken Fern), *Lycopodium clavatum* (Ground pine), *Nicandra physalodes* (Apple of Peru), *Scirpus cyperinus* (Wool grass), *Barleria cristata* (Phillipine violet), *Cortaderia selloana* (Pampas

grass), *Anaphilis busua* (Tall pearly everlasting), *Miscanthus* spp. (Silver grass), lichens, *Phragmites* spp. (common reed grass), *Davallia bullata* (Rabbit foot fern), *Tillandsia* spp. (Spanish moss), *Elsholtzia cristata* (Crested late summer mint) and *Setaria parviflora* (Bristly foxtail).

Mostly the plants collected are terrestrial in growth habit and generally found growing in the roadsides and damp areas. Only one plant viz., *Erioscirpus comosus* has a lithophytic growth habit which is found in abundance in the Bodak region. Amongst the plants collected, maximum number of genera belongs to the family of Poaceae (4), followed and Cyperaceae (2). The least represented families having single genus and single species are Dennstaedtiaceae, Lycopodiaceae, Solanaceae, Acanthaceae, Asteraceae, Davalliaceae, Bromeliaceae and Lamiaceae. The study also revealed that the plant parts mostly used for drying were seed heads of *Cortaderia selloana*, *Miscanthus* spp., *Phragmites* spp., *Erioscirpus comosus*, *Scirpus cyperinus*, *Setaria parviflora*; leaves of *Pteridium aquilinum*, *Lycopodium clavatum*, *Davallia bullata*; fruits of *Nicandra physalodes*, *Elsholtzia cristata*; flower of *Anaphilis busua*; dried calyx of *Barleria cristata* and stem of *Tillandsia* spp. Similar findings have also been reported by Singh *et al* (2017)<sup>8</sup> in the dried leaves of *Argyreia speciosa* and dried inflorescence of *Celosia argentea* and *Setaria verticillata*; by Brown (2016)<sup>9</sup> in dried grasses, reeds, pine cones, seed pods; by Raj & Gupta

(2005)<sup>10</sup> where naturally dried plant parts like, fruiting shoots of *Aegle marmelos*, *Bambusa* spp., *Cassia fistula*, *Caesalpinia sepiaria*, *Pinus roxburghii*, *Sapindus mukorossii* etc. and seeds of *Abrus precatorius/Aesculus indica*, *Sapium sebiferum* were collected.

Amongst the plants collected (Table 3), 12 species were found to be dried in natural growing conditions and needed no further drying. Only two foliage species viz., *Pteridium aquilinum* and *Davallia bullata* were press dried for 2 weeks of complete drying. The drying time of the specimens varies depending upon the moisture content of the foliage. Press drying of foliage of ferns, firethorn, hollyhocks, milkweed, thuja, silver-oaks, etc. as a suitable method for its preservation has also been reported<sup>11-13,1</sup>.

The plants evaluated during the present investigations have a great ornamental value with a very little shattering loss which can be kept under room temperature conditions as long as two years. The various plant parts also have been well utilized for making different kinds of dried floral products as presented in Table 4. Wall decors, greeting cards, table décor, bouquet, paper bags, dried floral arrangements, boutonniere, corsage, etc have been prepared from the collected dried plant parts. The usage of dehydrated ornamental plant parts for making products like calendar, floral bouquets, garlands, paper bags, greeting cards, flower baskets,

Table 3 — Techniques of drying native plants

Methods	Suitable Plants
Natural Drying	<i>Nicandra physalodes</i> , <i>Barleria cristata</i> , <i>Cortadesia selloana</i> , <i>Anaphilis busua</i> , <i>Miscanthus</i> spp., <i>Lycopodium clavatum</i> , <i>Scirpus cyperinus</i> , <i>Cortaderia selloana</i> , <i>Phragmites</i> spp., <i>Erioscirpus comosus</i> , <i>Setaria parviflora</i>
Press Drying	<i>Pteridium aquilinum</i> , <i>Davallia bullata</i>

Table 4 — Value added products from native ornamental plants

Species	Value added products
<i>Pteridium aquilinum</i>	Wall décor, greeting cards, photo frames
<i>Lycopodium clavatum</i>	Wall décor, greeting cards
<i>Nicandra physalodes</i>	Dried flower arrangement
<i>Scirpus cyperinus</i>	Dried flower arrangement, table décor, bouquet
<i>Barleria cristata</i>	Greeting cards, wall décor, paper bags
<i>Cortaderia selloana</i>	Wall décor,
<i>Anaphilis busua</i>	Table décor, greeting cards, boutonniere, corsage
<i>Miscanthus</i> spp.	Wall décor, table décor
<i>Phragmites</i> spp.	Wall décor, table décor
<i>Davallia abullata</i>	Greeting cards, paper bags, decor
<i>Tillandsia</i> spp.	Table décor
<i>Erioscirpus comosus</i>	Greeting cards, paper bags, wall/table décor, filler material
<i>Setaria parviflora</i>	Table décor, floral arrangements

jewellery, table and home decors, etc has also been described<sup>12,14-17</sup>. The natural process of drying and a simplified press drying method can be used for preserving the different plant parts viz., branches, foliage, stems, roots and flowers in their best possible form without any alteration in their physical characters so that one can use it for making value added products. Similar results have also been opined for making value added products from weed species *Dinebra arabica*, *Argyreia speciosa*, *Setaria verticillata*, *Dactyloctenium aegyptium*, *Cyperus rotundus*, *Celosia argentea*, *Digitaria sanguinalis*, *Echinochloa colonum* and *Eragrostis pilosa*<sup>8</sup>.

### Conclusion

To date, there has been very limited research undertaken to optimize the protocols and identify appropriate chemicals for preservation of native cut flowers and foliage. The process of drying to preserve the plant species has been developed mostly based on a non-systematic, trial and error basis. Thus, despite the considerable economic importance of this industry, it remains poorly defined in terms of its products, processes and organization. It is important that efforts be made to develop improved processing technology to support this growing industry and maximize the outturn quality of its products. In order to achieve these improvements, it is essential to firstly define the current situation, in terms of products and processes and identify the problems and difficulties faced by the producers.

The dried flower industry is still in a nascent stage and faces a tough competition with the fresh flower and indoor/pot plant trade since the consumers are largely focused on the qualities of attractive flowers, living plants and plant parts. Therefore, these products remained overlooked and underrated throughout the world. These are overlooked in the sense that their considerable economic importance is generally unrecognized and these are underrated in the sense that their aesthetic contribution is largely discounted. In contrast to the other areas of floriculture including post-harvest management, systematic research has not been taken up for dried flower and if at all, very few. The value of dried flowers and its contribution to the flower industry needs to be realized to conduct concentrated research and development with more professionalism in the trade of these products. In terms of value, the dried flower industry is very lucrative and profitable involving a low production

cost on account of its year-round availability, range of plant produce and its potential in export market. It is estimated that nearly 60% of the raw materials for dried flowers are found naturally in forests and hilly areas, while 40% flowers are cultivated specifically as dried flowers<sup>18</sup>. The value added products like the wall decors, greeting cards, bouquets, paper bags, etc. were sold in the market at a price ranging from Rs. 100 to 500/-. Since these flowers are easily available, it can be collected and processed into different products and can supplement their income by Rs. 500 to at least Rs. 5000 per month. A cottage industry based on floral craft can become a new area for self-employment of rural youth's and women through this creative occupation. The quest for searching new materials which can be utilized as dried flowers never ends and in fact is the demand of the hour. With the quest for discovering 'something new' in the world of floriculture trade, the native, wild species of plants has a good prospective which is still an untouched sector and needs to be identified and evaluated for future use in the industry. The wide availability of potential wild ornamental plants especially in the North eastern India will help in strengthening the dried flower industry in the region.

### Conflict of Interests

The authors declare that they have no conflict of interest.

### Author's Contributions

KCM and TSM conceptualized the paper and collected the specimens from different locations. KCM, SK and AP compiled the data, drafted the paper and provided inputs for publication. All authors have read the paper, provided valuable comments and approved the paper.

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