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Drying of flowers: A money-spinning aspect of floriculture industry

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Abstract
Demand of dry flowers and other ornamental products is continuously increasing due to their significant properties like everlasting quality, year around availability, eco-friendly and suitability for various flower arrangement products. This sector of agriculture is gaining popularity due to its potential and export-view. Dried flowers and plants have been exported for the last 40 years and today, India is one of the leading countries in this industry. This industry has received a major incentive for its high value, for they offer varied options for decorating interiors and living space. Different strategies required for the generation of dried attractive plant material includes air drying, press drying, embedded drying, oven drying and freeze drying in dried flower business. Due to continuous increase in demand of dry flowers, this sector is offering ample of job opportunities for thousands of unemployed man and women especially housewives.

Keywords: Dry flowers, ornamental, preservation, drying, floriculture

Introduction
The demand for ornamental flowers is ever increasing in the international and domestic market with the improvement in standard of living and quality of life. Flowers are delightful creation of nature considered as a symbol of love, beauty and a paradigm of life because of their countless colours. Government of India has identified floriculture as a sunrise industry and accorded it 100% export oriented status. Owing to steady increase in demand of flower floriculture has become one of the important Commercial trades in Agriculture [1]. The fresh flowers, though exquisite in their beauty, are expensive, short lived, sensitive to temperature and are available only during a particular season [2]. Their freshness and beauty is lost due to various biochemical changes and microbial activities, thus, can be retained only for few days even by using the best techniques of post-harvest management [3]. The shelf life of flowers could be prolonged only to an extent of 40% even when the best flower preservatives or chemicals were used [4]. So, dried flowers come as a smart alternative to fresh flowers and are looked upon as an economically significant industry.

What is Dry Flower technology?
Dry flowers are naturals, dried and preserved with an everlasting value that can be cherished for longer period [5]. Basically, it is a method of preservation of flowers by removing moisture from the flowers. Dried and preserved ornamental products offer a wide range of qualities like novelty, longevity, aesthetic properties, flexibility and year around availability [6]. The dried or dehydrated flowers or plant parts are natural, comparatively inexpensive and have everlasting value with year around availability [7]. Now, this process is moving from an art to a highly interdisciplinary science and has become a major economic activity on a global scale [8]. The range of dried flowers and other attractive plant parts is quite extensive, namely stems, roots, shoots, buds, flowers, inflorescences, fruits, fruiting shoots, cones, seeds, foliage, bracts, thorns, barks, lichens, fleshy fungi, mosses [9]. Dried flower products are in very high demand and add an enriched value to the flourishing industry. Various types of dry flower products are handmade paper, lampshades, wall quilt, decorations, books, candle holders, etc. The flower arrangements using dried samples of cone, foliage, flowers like rose buds, lilies and other such plant material enhances the beauty of dry flowers, adding more export value to this industry.

Indian Dry Flower Market
The most promising area in floriculture is the dry flower industry. Dried flowers and plants have been exported for the last 40 years and today, India is one of the leading countries in the field. The enthusiasm for dried flowers has expanded reliably throughout the most recent ten years.

Export of dried flowers and plants from India is more than Rs 150 crores per year. Potpourris are the major segment of dry flower industry valued at Rs 55 crores in India alone [10]. The export market of flowers in India is composed of 71% of dry flowers exported mainly to U.S.A, Japan, Australlia, Europe and Russia [11]. Exporting companies at Kolkata in West Bengal, Tuticorin in Tamil Nadu, Mumbai in Maharashtra and Hyderabad in Andhra Pradesh are earning 10-15 times higher returns than domestic markets [8]. India, with its vast resources, varied products and experience in the field of dried flowers and plants enjoy a distinct advantage.

Dry flower industry is a promising business in India since past four decades and was initially introduced by British in Calcutta due to its proximity to north east and eastern regions where exotic and various plants were easily accessible [12]. The market of dry flowers is growing very fast across the globe as the people has become more eco-conscious and choose eco-friendly and biodegradable substitute to fresh flowers [13]. Dried flower business in claim to fame bloom is an extremely beneficial wander now around the world.

Stage of harvesting for material

The quality of dry flowers is influenced mainly by the harvest stage of flowers and should be kept in mind before performing any drying technique. The appropriate stage of flower to be harvested is when they just began to mature or at a fully open stage although it varies according to the species and the form of desired flower [14]. For drying, fresh material is required; faded and old flowers and leaves should be rejected. The delay in harvesting time (2- 3 days) result in folding of petals over one another which causes their shattering [12]. As per requirement, different flowers can be collected at different stages [15]. The flowers should be cut just as they come to maturity [16].

Techniques of Flower Drying

Numerous methods are practised for dehydration of different flowers or its plant parts. In these methods, removal of moisture is done artificially either by using desiccants or controlled temperature, humidity and airflow. The principle involved in all the techniques is that the plant material is exposed to a vapour pressure deficit, which induces water vapour to move by transpiration or evaporation from the plant material (source) into the surrounding environment (sink).

- Air drying
- Water drying
- Sun drying
- Press drying
- Hot air Oven drying
- Microwave drying
- Embedding (silica gel)
- Freeze Drying
- Glycerine drying

Air Drying

Air drying flowers is one of the easiest methods of preservation and gives plants a crisp look that lasts for years. It is the most common method of drying also referred as "Upside Down" or "Hang and Dry" method of drying [8]. Air drying flowers make a fabulous decoration by themselves, but when they are dry, they make more beautiful and exotic flower arrangements. Air drying requires a warm clean dark and well-ventilated area with low humidity [17]. No special equipment is needed. The stems of flowers and their foliage are tied and hung upside down. The rooms should be warm, dark and dry with good air circulation. However, it is one of the longest drying methods. It usually takes three to four weeks for the flowers to dry completely [18]**.** Air drying in shade is applicable during dry season and summer particularly for flowers such as Acroclinum, Helichrysum and Limonium. Other crisp-textured flowers like Anaphilis, Delphinium, Oregano, Rumex and Holmskioldia, etc. can also be dried by air dry-ing [19]**.** Fleshier the flowers or foliage, the more time it will take to dry [20]. The stage of harvest is also important for getting superior quality of dry flower in this method. Blue and yellow coloured flowers retained their colour after air drying but pink colour fades away [21].

Water drying

Some flowers also dry well in water by the process of evaporation. The stems of flowers are initially placed in a couple of inches of water, then the water is allowed to evaporate and be taken up the cut flowers. The container and flowers should be in a dry, warm and dark location. Water drying, which usually seems like a contradiction in terms, gives fairly good results with flowers, e.g. hydrangeas, cornflower, Baby's Breath and a few others. Yarrow, hydrangeas, bells of Ireland, ageratums, alliums, acacia, celosia and gypsophilla do well with water drying [22].

Sun drying

Plant material is embedded in drying medium (sand) in a container and exposed to the sun daily to facilitate rapid dehydration. In India, open sun drying is followed for drying many flowers. In the sand the flowers are embedded in upside down form and put in the sun for drying for day or two [23]. Dubios (2005) reported that the greatest advantage of solar drying is that it is cheap [24]. Deepthi *et al*. (2008) stated that marigold, poppy, zinnia, chrysanthemum, acroclium and globe amaranths can be sun dried [25].

Press drying

One of the most popular methods for drying flowers is to put them under pressure, to remove the moisture out while leaving the color of the flowers and structure intact. Earlier it was used by the herbalists or botanists for the preparation of herbarium [26]. There are several ways to apply pressure to flowers. The easiest method is placing them in heavy books and allow for drying. The drying time can be reduced if the sheets are kept in oven at an appropriate temperature [27]. The material after press drying can be used for composing floral-craft items like; greeting cards, floral designs and other art creations which may be framed for wall pin-ups [28]. Time requirement for press drying of flowers vary depending upon the flower. Time required for press drying of different flower crops and they concluded that rose, carnation and helichrysum required 120, 132 and 72 h, respectively for press drying [29]. For quicker drying, a herbarium press should be kept in hot air oven at 450C for 12-24 hours depending upon the moisture in the flowers and foliage [30]. Plant materials suitable for pressing are Candytuft, Chrysanthemum, Pansy, Rose, Daisy, Phlox, Statice, Zinnia, Ferns, Silver Oak, Blue Gulmohar, Thuja, Cockscomb etc.

Microwave drying

Microwave drying is quick and relatively simple. The principle behind the microwave oven drying is liberating moisture by agitating water molecules in the organic substances with the help of electronically produced microwaves. It takes only a few minutes and provides dried

flowers that look fresher and more colorful than obtained by other methods. Flowers such as lilies, roses, violets, zinnias, and dahlias work well with this process. White *et al*. (2002) reported that microwave oven dried flowers looked fresh and more colourful than obtained by any other method. Aravinda and Jayanthi (2004) standardized the drying techniques like microwave drying, oven drying and sun drying for chrysanthemum (Button type local) flowers and found that microwave drying with silica gel gave the best results for retaining shape of flowers while oven drying with white sand was found the best for colour and overall acceptability [31]. Biswas and Dhua (2010) also studied on microwave oven drying of cut Carnation varieties *viz*., Kristina and Cano and found it effective [32].

Hot air Oven drying

Temperature plays an important role in drying of flowers and other plant parts and specimens are kept at controlled temperature conditions for a specified period of time in hot air oven [12]. The drying temperature also varied from species to species and plant to plant. 35-39°C temperature requirement was optimum for Bougainvillea (48 hours), Pompon Dahlias and Narcissus (72 hours) [33]. Higher the temperature, faster was the dehydration as well as degradation of pigments [34]. The anthocyanin content of flowers increased with increase in temperature which resulted in darkening of flower petals [35].

Embedded drying by Desiccants

Embedded drying is one of the method of flower dehydration useful for delicate flowers with high moisture content that shatter or misshapen when air dried. This method of drying is usually preferred over air or oven drying as it reduces the problem of petal shrinkage. In embedded drying, the water content of the flower is completely absorbed by the surrounding desiccant material during desiccation [36].

A desiccant is simply a substance with a high affinity for water which can be used as a drying agent. The desiccants provides the support to the material from all around and thus, maintains its original shape, colour and size of flowers for a long time [30]. Commonly used desiccants for embedded drying:

- Sand
- Silica gel
- Borax

Freeze Drying

Freeze drying works on the principle of lowering the temperature of material and then using a vacuum to extract all the moisture from it. It is a state-of-the-art technique and the most effective method for flower preservation today. It is an innovative vacuum process that takes approximately four weeks depending on the flower. The water vapour is collected in a separate chamber and the dried flowers are allowed to slowly warm to room temperature [37]**.** Sohn *et al.* (2003) studied the effect of freeze drying on Rosa hybrida cvs Tineke, Golden Gate, Saphir, Roulette, Rote Rose for 14 days on their shape and colour [38].

Table 1: Plant species suitable for preservation of foliage

Botanical Name	Common name	Methods			
		Air Drying	Microwave oven drying	Glycerine drying	Press drying
Adiantum assimile	Maiden hair fern			X	X
Agave Americana	Century plant	X		X	X
Alpinia sp	Shell ginger	X			
Anthurium andreanum	Anthurium		X		
Aralia filcifolia	Aralia		X	X	X
Araucaria excels	Monkey puzzle tree			X	
Artemisia martini	Dhavana	X		X	X
Asclepias	Milk weed	X			X
Aspidistra	Cast iron plant	X		X	
Bambusa	Bamboo	X		X	
Berberis	Barbery	X		X	
Butea monosperma	Flame of forest		X		
Buxus sempervirens	Box foliage	X	X	X	
Caladium	Caladium				X
Casuarina	Australian pine	X			
Callistemon lanceolatus	Bottlebrush		X	X	
Centella asiatica	Asiatic pennywort				X
Cyperus	Papyrus			X	X
Cycas revoluta	Sago palm	X		X	
Draceana sanderiana	Draceana		X		
Ficus religiosa	Peepul				
Grevilea robusta	Silver oak				
Hedera helix	English ivy		X	X	X
Monstera deliciosa	Monstera		X		
Nephrolepis sp	Ferns		X		
Nerium oleander	Oleander		X	X	
Philodendron bipennifolium	Philodendron		X		
Scindapsus aureus	Money plant		X		
Selasingella sp	Club moss		X		
Scheflera arboricola	Umbrella tree		X	X	
Thuja orientalis	Thuja		X	X	X

(Geetha *et al.*, 2004) [42]

Glycerine Drying

In this method moisture in a flower or foliage is replaced with glycerin and water. The flower is preserved and not dried. Dried materials retain their natural shape and flexibility. In glycerine drying, the quality of the product remains good as moisture in flower is replaced by a mixture of water and glycerine [15]. Plant species such as anthurium, aspidistra, beech, bells of Ireland, cotoneaster, crabapple, dracaena, English ivy, eucalyptus, galax, juniper, lemon, magnolia, mountain ash, maples, myrtle, oaks, orange holly grape, peony, periwinkle, purple leaf plum, poplar, quince, Russian olive, salal, spirea, statice, sweet gum, and weigela can be treated with glycerin. Glycerinisation is best for preserving small leafy tree branches [39]. Glycerin preserves foliages by replacing the natural moisture present in the leaf with glycerin and maintains the leaf form, texture and colour [40]. Treatment of foliages with glycerin yield unique results, although stem and leaves turn brown in this process, they will remain flexible and pliable indefinitely [41].

Dry Flower Products

Table 2: Dry flower products

1.	Floral craft items	9.	Wall Quilt
2.	Potpourri	10.	calendars
3.	Boxes	11.	Topiary
4.	Photo Frames	12.	Jute Bags
5.	Candle Holders	13.	Cards
6.	Carry Bags	14.	Decoration
7.	Handmade Paper	15.	Greeting cards
8.	Lamp shades	16.	floral balls

Care and handling of Dry products

Dry flowers are very fragile and brittle in nature, so they should be handled with utmost care. Dried plant material should be protected from moisture throughout the marketing channel by placing a small quantity of silica gel at the bottom to absorb moisture. Different containers like glass desiccators, tin boxes and cartons wrapped with plastic sheets or wax paper are used for storage. Dried material should be protected from direct sunlight, place in warm, dark and well-ventilated area

Scope and opportunities in dry flower industry

Dried flowers and plant parts are eco-friendly, long lasting, biodegradable and easily available and, therefore, possess a great potential in floriculture industry throughout the world especially in the hilly regions of India. It is estimated that about 80% of flower species can be dried and preserved successfully. Excessive variation of wild plant material available widely also strengthen the establishment of dry flower industry. Dry flower industry has the potential to provide employment to thousands of people especially to housewives and rural women's as limitless aesthetic and decorative products can be created using dry flower technology. So, there is an immediate need to strengthen its market, financial assistance through government agencies and training for entrepreneurship development and awareness about the potential of this technology by workshops, exhibitions and seminars etc.

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